FHWA Contract Administration Techniques for Quality Enhancement Study Tour (CATQEST)

FHWA's Scanning Program

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The metric units reported are those used in common practice by the persons interviewed. They have not been converted to pure SI units since, in some cases, the level of precision implied would have been changed.

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FHWA International Technology Scanning Program

Summary Report of the

Contract Administration Techniques for Quality Enhancement Study Tour (CATQEST)

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Purpose and Methods

There is a widespread impression in the United States that roads and highway structures in Europe are generally superior to comparable facilities in the United States. The subjective criteria commonly cited in reaching this consensus have been the ride quality and durability of the pavements and the environmental compatibility, beauty, and durability of auxiliary facilities such as major bridges, retaining walls, and noise barriers.

In an effort to determine if Europeans are more successful than Americans in achieving consistently high quality levels, study tours were conducted to investigate design and construction practices for roadway pavements, structures, and geotechnical slope-stabilizing practices in selected European countries. The results from these and other studies suggested that special contract administration techniques and practices used in Europe, as well as design and construction practices and funding levels, may help explain the consistently high-quality achievements enjoyed in those countries.

Accordingly, this joint industry and government project, the Contract Administration Techniques for Quality Enhancement Study Tour (CATQEST), was organized to examine contract administration practices in Germany, France, Austria, and Spain. The primary objective of CATQEST was to look at the relationship between contract administration practices that are not common in the United States and the high quality in the highways in these countries and to determine if such practices were potentially adaptable for use in the United States.

To conduct the study, a team of U.S. Federal, State, and private industry representatives was organized. The team met in the four countries with primary transportation officials, individual contractors, contractor and engineering associations, local and regional roads administration personnel, independent consulting engineers, and independent testing-laboratory officials. Inspection trips were conducted to active construction projects in each country. A final meeting of the team reached some general conclusions as follows.

Contract Administration

Some techniques in highway contract administration that are different in Europe from those in the United States include (1) use of guarantees and warranties; (2) commonly awarding contracts on the basis of best, rather than lowest, bids; and (3) greater use of alternative proposals (with options) in the award determination processes.

Warranties

The matter of extended warranties was cited as a positive influence on sustained high quality by some tour hosts, but there is no clear consensus in this regard. Some team members believe that since (1) this factor has been isolated as clearly unique by U.S. standards, (2) it has been used for several decades by some countries studied, and (3) some European officials believe it

has been a positive influence on sustained high quality for decades, warranties should be recognized as a potential quality-enhancement factor justifying further study.

A team consensus was that the frequent use of warranties against defects in workmanship and materials in Europe was not the driving force behind quality. Greater emphasis in the United States on increased funding levels, higher design standards, quality control/assurance, tougher enforcement of performance-related specifications, rapid-result testing, and prequalification of bidders would yield more immediate, positive results in the quest for improved quality.

In general, it was found that the need to enforce the provisions of the warranty by the contracting agencies was very rare. This is consistent with the high degree of cooperation that exists between the owners and the construction industry, which results in a very limited number of claims or cases of litigation being used to resolve disputes.

Best-Bid Awards

The "best-bid" award practice has been cited in previous reports and has generated considerable interest, since it seemingly violates the U.S. principle of open and equal competition in which all bids are based on specific items of work, materials, etc., as specified by the owner, and the contract is awarded to the lowest responsible bidder.

In 1933 the following policy statement, attributed to the Inspector General of the German Highway Administration, was issued:

"It is not always the lowest bid which should be given preference. Quality is the most important criterion."

It can be speculated that from this statement evolved the best-bid award terminology and the mistaken perception that it has become the dominant award practice in European countries. The facts actually seem to be that the so-called "best-bid" procedures used on the vast majority of projects in Europe result in the award going to the lowest responsive bid. Awards made under best-bid procedures are based on the acceptance of alternate proposals. In France this type of award procedure is usually limited to projects reserved for the concessionaires, to design/build projects, and to projects for complex, highly specialized structures bid under the selective invitation procedure.

Alternate Proposals/Value Engineering

The European countries allow and even encourage contractors to submit alternate proposals along with their regular bid submissions. This practice stimulates innovation as well as competition and has resulted in numerous improved design and construction concepts and techniques that were developed by contractors.

The alternate-proposal practice in Europe differs from the United States value engineering (VE) practice in one major respect: Alternate proposals are accepted and considered prior to contract award, while value engineering change proposals are offered by the successful bidder only after the firm has been awarded the contract based on the low bid.

Quality

In all four countries visited, there seemed to be a quality-first outlook that spanned the entire industry, from government transportation agencies, the academic community, consulting engineers, and the construction industry down to the project workers. The term "quality" did have a somewhat different meaning in each of the countries visited. There also seemed to exist a mutual desire among all elements of the industry to establish and maintain a cooperative working relationship. They believed an adversarial environment is detrimental to achieving the quality levels they all seek.

Even so, it was recognized that in the contractor-owner relationship, it is sometimes difficult to maintain a high level of cooperation without some risk. If the cooperative relationship becomes too close or "cozy," it could lead to compromising the authority and, possibly, the integrity of the public officials who are entrusted with public funds. Even the appearance of impropriety could be devastating to the public's trust and support of highway programs.

In all contractual dealings and relationships, it is important to keep in mind that contractors are in business to make money, while the owners are obligated to obtain the best product possible for the money paid. In Europe, it seems possible that the best of both worlds exist in this regard, and that a positive, workable balance has been achieved.

Key elements that appear to contribute most to the long-term quality of roadways in Europe are as follows:

- Europeans design and construct stable, high-quality, and well-drained pavement substructures.

- Although the design life is generally 20 years for flexible and 30 years for rigid pavements, Europeans have set high pavement-design standards that accommodate heavier axle weights in the design analyses. This results in construction of higher-strength pavement and base sections than are normally called for in the United States. In addition, Europeans rigidly enforce contract and specification requirements in the construction phase.

- Europeans use quality control plans on a majority of their projects. These require the contractor to follow an approved plan utilizing qualified personnel for testing and controlling materials. Likewise, a significant emphasis is placed on quality at all levels of program/project involvement, including planning and the design aspects of the construction plans.

- Europeans have aggressive preventive maintenance programs that are designed to preempt the need for more costly and disruptive surface-repair projects, and they have very aggressive reactive response procedures when preventive measures fail or other emergency situations arise.

- All four countries have higher fuel taxes and investment levels than the United States. The European countries are willing to dedicate more resources to infrastructure. Higher investment levels allow greater consideration of the use of higher front-end investment

strategies that provide for lower life-cycle costs, including public and private-user costs. The higher investment strategies also carry through to rehabilitation and maintenance as well as in construction.

Many European contract administration procedures that led to high quality roads were interrelated and may depend on aspects of European culture that are different from American society. That is, quality of construction, level of maintenance, use of high design standards, greater investment levels, use of best bids, use of warranties, etc., all fit together within a European framework; some team members cautioned that transferring only a subset to the United States might not achieve the desired improvements. Others felt that with appropriate discretion learning from successful road builders abroad can be effective research for better American highways.

Table E-1 briefly summarizes the main conclusions and recommendations of the CATQEST study. The full report contains a discussion of each of the items in the table.

Table E-1
Summary of Findings and Recommendations

Contract Administration Techniques for Quality Enhancement Study Tour of Europe (September 20 to October 1, 1993)

Findings	U.S. Policies	Recommendations
Alternate Bids Used in Europe.	United States awards to lowest responsible bidder.	Use alternate bids within the low-bid framework (i.e., consider using contract time, VE, etc.) with defined guidelines up front. (The philosophy of alternate bids is to encourage contractor innovation.)
Best-buy Approach (Germany, France, Spain)	Best-buy approach adds subjectivity to award process.	Not recommended.
Guarantees/Warranties Not the driving force behind quality.	Bonding impacts/requirements, and concerns from financial institutions.	Study further. Place greater emphasis on quality assurance, prequalification, performance-based specs., higher design stds., tougher enforcement of specs., and performance and rapid-result tests.
Design Issues • higher design life • preventive maintenance • use of stage construction with a strong pavement base • use life-cycle cost methods	Adequate funding. Political will.	Promote R&D and fewer regulations. Emphasize life-cycle cost techniques & preventive maintenance, particularly on the NHS (AASHTO & FHWA with Industry).

Findings	U.S. Policies	Recommendations
Value Engineering • design • construction	Currently being promoted.	Emphasize improving the effectiveness of the VE program. Promote to States not using VE and expand use in others.
Design Standards Use of catalog for standard pavement designs.	No impediment.	Consider development and use of higher pavement design standards on the NHS.
Design/Build Concept Used on limited basis, not being promoted.	Limited experience.	Not recommended except for special projects.
Contractor Qualifications	• DBE program. • Small businesses. • New businesses.	Study current system. Develop objective criteria to improve upon contractor performance (ISO 9000).
Enhanced R&D on New Products/Methods Government & industry work together closely.	Government/industry independence.	Promote the Hi-Tech Center concept. (FHWA & AASHTO) Consider using regional centers/educational institutions.
Close Owner/Contractor Coordination (limited number of claims)	Litigious society.	Promote partnership concept, better design reviews, encourage more designer and contractor input in design and construction and ADR.
Proactive Environmental Treatments • surface drainage collection • pavement noise concerns • landscaping • urban design • flora/fauna bridges • architectural treatments	Funding concerns.	Proactive owners, AASHTO, & FHWA utilize joint promotion efforts of new technology.
Training (contractor & owner's staff)	• Limited OJT program. • Union programs.	Establish a formal construction training program. Suggest establishment of a construction training institute (industry and government jointly).
Quality Control/Quality Assurance (QC/QA)	Overcome resistance.	Establish and require contractor QC/QA plans. Establish TQM at all levels and for all participants. Retain acceptance by owner, but allow use of contractor control tests for statistical validation.
Uniform Performance Measures (French approach)	States' rights flexibility.	Develop a quality level index for both acceptance of projects and long-term measure of performance on NHS.
National Highway System For new facilities or additions	Mandated statewide planning processes.	Increase the national leadership in establishing a national plan. Approval of the National Highway System with resources to ensure its completion and maintenance is a comparable approach.

1. INTRODUCTION

1.1 Background

There is an ongoing, comprehensive effort in the United States to identify procedures and promote activities that will enhance the quality of highways. The many facets of this effort are included in the "National Quality Initiative" (NQI). The NQI is endorsed and supported by all segments of the highway industry in the United States. It is a unique partnership between FHWA, American Association of State Highway and Transportation Officials (AASHTO), and various industry associations to focus national attention toward constant quality improvement within the entire highway community. This national focus on quality came from development of a national policy on the quality of highways, a number of national and State-level seminars to provide information and increase awareness for quality improvement, and development of a long-range plan for continuation of the emphasis on the NQI activities and supporting concepts.

The pursuit of quality has led to several scanning tours by U.S. highway officials and industry representatives to other countries generally credited with having high-quality roads. The specific subjects of two of these tours were asphalt- and concrete-paved highways. These were conducted in 1990 and 1992, respectively. Reports covering these tours were subsequently published under the titles *European Asphalt Study Tour (EAST) 1990* and *Tour of European Concrete Highways (TECH) 1992*. (A third report of this scanning series was on a specific technology for auxiliary structures, geotechnical [soil-nailing] techniques for slope stabilization.)

While the primary objectives of these tours were to study design and construction practices and overall performance of the pavements, the studies also identified several innovative practices outside of the technical parameters of design and construction. Specifically, certain unique contract administration practices were identified that warranted further investigation and evaluation.

A general conclusion could be drawn from the EAST and TECH reports that European pavements are superior to pavements on comparable roadways in the United States. It could further be inferred that this superior quality could be due, in part, to very high, long-term design standards and construction specification requirements, to a long history of high levels of investment, and perhaps to innovative or unique contracting and contract administration practices in the European countries studied.

The Transportation Research Board (TRB), in a separate study, also identified possible contract administration quality-enhancement procedures that they considered worthy of further study or implementation. Some of these procedures were the same as reported in the tour reports. Transportation Research Board Circular No. 386, dated December 1991 and titled "Innovative Contracting Practices," documents the results.

1.2 Purpose of Study

The results of the TRB study and the pavement tour reports provided impetus for the Federal Highway Administration to initiate this study tour to selected European countries to evaluate contract administration procedures. The primary objective of the tour, called "Contract Administration Techniques for Quality Enhancement Study Tour" (CATQEST), was to attempt to link innovative contract administration practices with high-quality levels of highways in Europe. Further, if such linkage could be verified, then the study was to determine if the innovative practices were potentially adaptable for use in the United States.

1.3 Methodology of Study

The Transportation Technology Evaluation Center (TTEC) of Loyola College in Maryland was selected to coordinate the CATQEST study tour. Fourteen participants were selected to represent a cross section from the Federal Highway Administration (FHWA) and State transportation departments, the American Consulting Engineers Council, the National Asphalt Pavement Association (NAPA), the American Concrete Pavement Association (ACPA) and representatives of the American Road and Transportation Builders Association (ARTBA) and the Associated General Contractors of America (AGC). A fifteenth member of the technical team was retained by TTEC to participate in the study tour as report facilitator.

From September 20 through October 2, 1993, the scanning team visited Germany, France, Austria, and Spain. Meetings were held in each country with primary transportation officials, individual contractors, contractor associations, local and regional road administration personnel, independent consulting engineers, and independent testing laboratory officials. Inspection trips to active construction projects in each country were conducted. Formal presentations by host country officials were delivered at most meetings. The presentations directly addressed questions that had been submitted by TTEC several weeks prior to the visit by the CATQEST team (Appendix 10.3). Appendix 10.4 contains a list of sites and individuals visited.

To obtain the broadest perspective possible, the same basic questions were asked of each group. In addition, many small group discussions took place. These informal discussions elicited many candid individual opinions and insights that provided the group with a more complete understanding of the merits and negative aspects of some of the procedures and techniques being utilized. The entire group participated in all project inspections and meetings. However, the group was divided into four teams, and each team was assigned primary responsibility for summarizing the data obtained from one country.

1.4 Preview of Report

The primary focus of the tour was on contract administration procedures. Accordingly, this report attempts to stress that issue in more detail than other facets of the administration of highway programs in the host countries. However, because insights were gained on essentially all aspects of the highway programs in

Germany, France, Austria, and Spain, many additional issues are addressed in a general way. It is believed that this will provide readers a more complete perspective from which to evaluate contract administration issues. Table 1 presents a concise summary of the demographics of the four countries compared to those of the United States.

Table 1
Demographics

Parameter	Germany Unified	France	Austria	Spain	United States
Area (km^2)	365,000	551,670	84,000	505,000	9,392,600
Population (millions)	80	56	7.6	39	253
Population density (per km^2)	219	102	90	77	27
GDP-billions (US$)	1,157	873	111	436	5,465
Per capita income (US$)	14,600	15,500	14,500	11,100	21,800
Road km:					
Total	494,590	916,216	200,000	318,000	6,279,030
Interstate-type Roads	11,000	8,041	1,858	538	73,212
Toll Roads	0	6,801	145	2,500	11,400
Fatalities (per 100 million km traveled)	1.9	2.5	2.3	6.8	1.4
Fuel tax (US$)					
Per liter	0.64	0.80	1.00	0.68	0.05**
Per gallon	2.40	3.04	3.78	2.58	0.18**
Annual road investment (US$ billions)	6.6	2.4*	2.18	3.0	20**

Data sources: For consistency, data for the five countries were taken from the *World Factbook 1991* and the 1992 IRF *World Road Statistics 1987-1991* where possible. Slightly different data are presented in the country summaries because of a different year, different definitions, etc.

* Not including toll motorways, which are financed by toll collections

** Federal level only in 1993; average State tax collected: $0.19 per gallon.

1.5 Team Members

The CATQEST[1] team was composed of the following Federal, State, and private-industry representatives:

Name	Representing	Organization
Anthony Kane	Team Leader	FHWA, Washington, DC
David Geiger	Contract Administration	FHWA, Washington, DC
Robert Bohman	TTEC Report Facilitator	Consulting Engineer
Dwight Bower	AASHTO	Idaho DOT
Dan Flowers	AASHTO	Arkansas DOT
Hank Honeywell	Division Administrator	FHWA, Helena, MT
Erik Jensen	ACPA	Irving F. Jensen Co.
Hal Kassoff	AASHTO	Maryland DOT
David Kraemer	ARTBA	Edward Kraemer & Sons
Larry Smith	Engineering & Operations	FHWA, Washington, DC
Richard Sparlin	ACEC	Centennial Engineering, Inc.
Dean Testa	AASHTO	Kansas DOT
Pete Wert	AGC	Haskell Lemon Construction
Richard Wilcox	ACEC	Wilcox Associates, Inc.
Robert Ulland	NAPA	Ulland Brothers, Inc.

The team was accompanied by representatives of American Trade Initiatives, Inc., a travel liaison subcontractor employed by TTEC to ensure proper meeting arrangements and smooth travel.

[1]A glossary is provided in Appendix 10.2.

2. MAJOR FINDINGS

2.1 Project Development and Design

2.1.1 Life-cycle Costing

Life-cycle costing is not uniformly used in European countries, and none of those countries visited formally use the process and cost-measuring criteria as defined in the United States. All of the countries studied use a predicted design life for pavements, but their approaches to relating costs to life expectancy of the facilities vary substantially, especially on bituminous-surfaced roads. While the countries did not use formalized life-cycle cost analysis, their design and investment philosophies were based on life-cycle thinking. They clearly had minimization of government and private-sector costs in mind.

For example, the general practice in Germany is to construct bituminous pavements to full structural design standards and invest heavily in initial construction. This reduces the need for heavy maintenance expenditures during the predicted life cycle. As a result, their life-cycle cost analyses do not include a significant cost for maintenance. They do, however, budget a lump-sum amount for general maintenance purposes. The German approach on rigid pavement of using a long design life and full depth pavements with expensive base and sub-base treatments may not be used in the eastern part of Germany due to financial constraints. However, German officials clearly see the relationship between adequate investment levels and quality designs.

The French, on the other hand, invest less in the pavement structure initially, but budget for periodic stage construction overlays at 8- to 10-year intervals, during and beyond the 20-year design life period. The cost of these overlays is included in estimated life-cycle costs.

Austria's procedures are now quite similar to those used in France. However, the Austrians indicated that their current objective is to reduce overlay maintenance costs by investing more heavily in the initial pavement construction, as is done in Germany.

The Spanish generally design and build to a full 20-year life expectancy and perform maintenance as required during the design period. However, for cost/benefit analyses in the planning process, they assume a 30-year useful life and a 15-percent residual value at the end of the useful life period. Thus, their life-cycle cost calculations include the estimated initial construction cost, plus the estimated 30-year maintenance costs, less the 15-percent residual value.

Road user costs in the form of traffic delays, vehicle wear and tear, and motor fuel costs are, again, not uniformly considered in life-cycle cost calculations. These factors are more likely to be considered in benefit/cost ratio analyses to rank projects for advancement to the construction stage. These alternate policies in pavement design, construction, and maintenance are the subject of considerable debate in the European Union (EU) at this time.

2.1.2 Project Development Constraints

In Europe, ecological, environmental, and aesthetic concerns and issues are major factors contributing to long-range planning and project design processes. The general public and individual communities impacted by highway construction and operations are becoming more demanding and more involved in the planning and design processes with regard to these factors.

The countries studied on this tour, in general, are trying to ease time-consuming development constraints. In Germany, legislation is pending to remove many existing project approval steps, which will reduce typical project development time from 10–12 years to 5–6 years.

2.1.3 Design Parameters

In the countries studied, pavement design life generally varies from 15–20 years for flexible pavement to 20–30 years for rigid pavements. However, as discussed under "Life-cycle Costing," the amount of maintenance and repair required during the design life of a pavement varies considerably.

For example, the French indicated that 60 percent of their planned investment for pavements is for construction and 40 percent is for maintenance. In Germany, the planned investment breakdown is 95 percent for construction and 5 percent for maintenance. Part of this substantial difference is probably due to definitions of "maintenance" and "construction." Europeans tend to use the term "maintenance" for all activities after initial construction, including overlays. Whatever the cause, this wide disparity in the ratio of construction-to-maintenance costs is an important issue for debate in Europe.

EU members have established maximum load limits of 11.5 metric tons (mt) (12.7 US tons) for single axles, 19 mt (21 US tons) per tandem axle, and 38 mt (42 US tons) gross vehicle weight. It is anticipated that all EU members will adopt these as legal limits, if they have not already done so. All countries studied had difficulties enforcing legal load limits, and they believe this will continue to be a problem throughout the EU. Some of the countries indicated that their pavement design procedures make allowances for a substantial overload.

One common theme for the countries visited was the recognition that high-quality, well-drained and stable roadbeds were essential to high-quality, durable pavement structures. There was no indication that the integrity of the roadbed and pavement foundation would ever be sacrificed for the sake of economy by reducing design standards.

Geometric design parameters are not uniform throughout the countries studied. However, there appears to be a common, increased effort to enhance safety-related geometric features by increasing shoulder widths, increasing width of clear zones, and flattening the side slopes. The EU is also trying to develop standards to be applied throughout Europe.

2.1.4 Use of Design Consultants

Use of design consultants varies by country and even by region within individual countries. The extent of use is generally

dependent on the availability of qualified government or state engineers. Personnel resources are normally established and controlled by legislatively mandated personnel ceilings and budget limitations for administration. For consultants, a qualification-based selection process is used. The eastern part of the newly unified Germany (for example, Brandenburg) is using design consultants heavily because of the lack of trained personnel and the expanded workload in upgrading roads in the former East Germany.

2.1.5 Construction Contractor Involvement

The involvement of construction contractors in design is usually limited to projects administered under the design/build procedure, on projects that invite alternate bid proposals, and at times on projects for which unsolicited alternative proposals are accepted for contract award.

The design/build concept does not appear to be widely used in the EU at the present time. It has been used recently on one large toll-road project in the former East German State of Brandenburg, where most of the design criteria had been set by the adjacent lanes. The German experience was disappointing, and no further use is planned at this time. It has also been used on a limited basis in Spain.

2.1.6 Design Quality Control

The central government or state governments perform second-level reviews of all planning and design documents on projects designed by government engineers. They also review all consultant-provided designs and plans. Normally these reviews focus on technical accuracy and compliance with governing standards and regulations. On some complex projects designed by consultants, a second consultant engineering firm is employed to review the primary consultant's evaluations of alternatives and final designs.

2.2 Contract Award Procedures

2.2.1 Open Competitive Bidding

Open competitive bidding procedures, by European standards and definition, are most commonly used and, in some of the countries, are mandated by law. Under these procedures, projects are normally advertised on a nationwide basis.

For contract awards under EU agreements, a notice must also be published in the official *Journal of the European Community* when the value or cost of the project is estimated to be US$5,000,000 or more. In either case, interested contractors, worldwide, are free to submit bids.

Shortly after the bid submission due date, all bids that have been received are evaluated by comprehensive procedures, using both subjective and objective criteria. Prominent among these are: bid amount, technical adequacy, planned construction schedule, overall quality of the bid, and bidder's past performance and reliability. Another key element of the bid evaluation criteria is the contractor's current work load related to its capacity (personnel and equipment). This is considered so as to assure successful completion of the work. Following the initial evaluation, a short list is developed for further evaluation and

consideration. In most cases, the lowest bid on the short list is determined to be the best bid, and the award will be made on that basis. Nevertheless, the flexibility is there to be used when necessary to award contracts to the best bidder, who need not be the lowest.

The Europeans use the "best buy" concept to assure that they award the work to a quality contractor. Although a portion of the decision is subjective, their evaluation tends to assure that the selected contractor can finish the job on time, on budget, and according to the requirements. The quality in this system is reflected in the fact that the countries visited rarely have to deal with contract changes or claims/litigation. This approach also reflects the fact that incentives/disincentives are not needed when everyone understands what is expected before the award. They use the best-buy approach to assure themselves of good work and assure the contractor of a profit; both probably benefit the public in the reduction of the cost of disputes and bankrupt contractors. The system is part of European culture, but would be very difficult to implement in the United States, because laws and culture dictate the low-bid system.

2.2.2 Other Award Procedures

Other award procedures used vary in some ways from country to country. Even when procedures are very nearly the same, different terminology may be used to describe essentially the same procedures. In general, in addition to the open competitive procedure, all countries could be considered to use selective invitations and direct contracting procedures. Both of these procedures could also be considered to be competitive since two or more bids are evaluated before the award decision is made. With selective invitations, the bidders may submit alternate bids for consideration by the owner. When alternate bids are submitted, the contracting organization takes these into account, and the low bid may not be the actual bid that is selected. Selective invitations are used, on occasion, when the project is of such size and complexity that realistically only a few contractors could build it. Direct contracting under low-bid procedures is used for minor projects. A more detailed description of award procedures is discussed in the individual country reports.

2.2.3 Road User Cost and Time Considerations

Road user cost and time considerations are not normally considered in the basic project plans and specifications. However, work scheduling, construction time tables, and completion date projections submitted by bidders are given weight and could be decisive factors in award determination. In addition, alternate proposals that, if accepted, would result in shorter road closure times, less inconvenience, and greater safety to road users might also result in award of the contract based on the alternate proposal.

2.2.4 Prequalification of Contractors

Contractors are not prequalified to bid in the same sense as the term is used in the United States. Usually, only such things as business licenses or registration are required to qualify for participation in the bidding process. However, in order to become licensed, the applicants must meet certain educational, prior experience, and

financial soundness requirements. A form of prequalification or preselection is commonly used on many projects under the selective and direct contracting award procedures. In these cases it is predetermined which contractors are eligible to compete for particular projects. Many of the same screening criteria utilized in evaluating bids under all award procedures in the countries studied are essentially the same as those used in the United States when prequalifying contractors. Two basic distinctions are that the Europeans do not use the term "prequalification" and, in the case of open competitive procedures, most of the evaluation and screening is done after bids are received rather than before bids are submitted. Much of the European pre-award evaluation seems to be similar to the postqualification activity that some U.S. States use. In each country the CATQEST group found large construction contractors that tended to capture a large market share.

2.2.5 Subcontracting Procedures

Subcontracting procedures and utilization vary considerably in Europe. The Spanish permit subcontracting up to 50 percent of the contract amount, and it is not unusual to subcontract up to that limit. On the other hand, subcontracting is hardly ever used in Austria. The usual practice there is to form joint ventures resulting in a capability to directly perform all required work on a project with little subcontracting. Subcontracting in Germany and France is permitted, but is not widely practiced. Most of the larger contracts in those countries are awarded to large companies with broad capabilities to perform work of all kinds, similar to the joint venturers in Austria.

2.3 Construction Quality Control

2.3.1 Specifications

Semantics can lead to misunderstandings when defining specification types with one- or two-word descriptions. Generally, the countries studied consider their specifications to be both "end-result" and "performance-based," because their standards and specified quality parameters are designed and prescribed specifically to assure the desired end results and levels of performance.

In American terminology, most of their specifications would be considered a combination of "methods" and "end-result" specifications. For example, on concrete for paving, such things as water/cement ratio, minimum cement factor, and mineral aggregate properties are specific contractual requirements. Thus, the end result of this prescriptive method must meet specified strength and smoothness requirements. In many cases, the specific mixture proportion or design is created by contractors and is approved for use by the owners. Contractors generally have considerable latitude to choose what equipment and procedures they will use to produce the specified end results.

Cooperation between owner agencies and the construction industry in formulating general specification requirements has resulted in clear, unambiguous, and binding specification requirements. They are generally understood and agreed to by both parties. This cooperation is considered important if high-quality construction is to be attained and disputes and claims are to be minimized. In all host countries, enforcement of construction specification

requirements is rigorous, with very few exceptions. Any substantive failure to meet the requirements has resulted in removal and replacement of substandard work at the contractor's expense.

2.3.2 Contractor Quality Control

Contractors are wholly responsible for quality control during the construction of projects, with the agencies providing quality assurance oversight either through in-house staff or consultants. Some countries require contractors to develop formal quality-control plans for sampling, testing, inspection, and second-level oversight to be used during construction of individual projects. Most countries also require that contractors' quality-control programs be directed by a professional engineer. Quality-control activities may be performed either by qualified contractor personnel, by consultants, or by private sampling and testing companies employed by the contractor. In Spain, the law requires contractors to spend up to one percent of the total contract cost on quality control or quality assurance. The law does not require the contractor to submit a formal project quality-control plan. Some autonomous regions require such a plan and some do not. It should be noted, however, that all European countries are moving towards having contractors' internal quality-control programs certified through government or international standards, such as ISO 9000, to supplement or support their acceptance of contractor quality control.

2.3.3 Work Force Training and Certification

Training and certification requirements for contractor personnel vary widely but are considered quite important. All countries require that contractors' project superintendents or quality-control engineers be registered to perform on a professional engineering level.

In Germany, construction workers are trained by individual contractors in 3-year, on-the-job apprenticeship programs. The Government sponsors and pays for structured academic courses for qualified apprentices during the third year of the program. Some other countries consider technician and skills training for construction personnel to be the sole responsibility of the construction industry and, accordingly, have little involvement in work force training or certification activities.

2.3.4 Incentives and Price Adjustments

Incentive and disincentive clauses in contracts are seldom used in the countries reviewed. However, incentives are sometimes manifested indirectly through acceptance of alternative bids that indicate there would be economic benefit to the government. None of the countries provides an incentive for exceeding the specified minimum quality level, but some contracts may include a bonus for early completion.

The Europeans generally seemed to place considerable emphasis on the design and "best buy" part of project delivery, to the point that they feel that when both owner and contractor know exactly what is expected, incentives or penalties are not necessary. They also appeared to put major emphasis on compliance with requirements during construction; noncompliant work is removed rather than accepted at a lower price, again eliminating the need for price adjustments to entice contractors to provide higher quality. It is important to note that, in a subjective best-bid environment, competition is inherently limited and the work is priced to cover this cost.

In Austria, price reductions are used similar to the way they are used in the United States. In such cases, the amount of price reduction is determined by formulae, based on statistical analyses of test results. By contrast, in Germany, price reductions for failure to meet requirements are almost never used.

2.3.5 Legal Issues

Legal issues and contract disputes are not major issues in the European countries studied. Generally, the attitude in these countries is that of mutual cooperation between contractors and government and a cooperative effort to minimize ambiguities; the high quality of plans and the clear specifications also contribute to this nonlitigious environment. When disputes or misunderstandings do occur, they are generally resolved at the project level. In a best-bid environment, litigation by the contractor would be counterproductive and destructive of a mutually beneficial relationship.

2.4 Quality Assessment and Performance Evaluation

2.4.1 Definition and Measurement of Quality

The broad definition of "quality," as described by the European countries visited, includes three general elements. First, the product (road) must meet the needs and expectations of the public, in terms of safety, durability, aesthetics, convenience of use, and impact on the environment. Second, these factors must be adequately addressed both in the form of designs, plans, and specifications on an individual-project basis, and in regulatory, administrative, and operational procedures on a program-wide basis. The final measure of quality is the level of compliance with specific contractual requirements and specifications, as determined by sampling, testing, inspection, and other project administration activities. This approach to quality has been jointly developed and supported by the government and the contractors and is financially supported and encouraged by the best-bid philosophy.

One German official defined the third element of quality most succinctly: "Quality means 100 percent compliance with contract requirements. No more. No less."

2.4.2 Quality Assurance Programs

Quality assurance programs vary throughout and within the countries studied. Generally, however, quality assurance efforts are project-level efforts shared by contractors and the governments. Most programs include minimum sampling

and testing programs for both contractors and the owner agencies. Generally, the contractors' programs are considered to be self-monitoring quality-control efforts, while the owners' programs are intended to monitor and verify the efficacy and reliability of the contractors' programs. Almost without exception, governmental acceptance of products and items is based on the independent sampling and testing performed by or for the government.

2.4.3 Warranties and Guarantees

Contractors in all of the countries reviewed are normally required to warrant their work against defects in workmanship and materials for at least 1 year. The length of extended warranties varies widely from country to country. In France, for example, most work carried a 1-year warranty; extended warranties, running up to 4 years, were limited to the concessionaire-administered facilities and proprietary products. In Germany, a period of 5 years was demanded on bridges and earthwork, and in Austria a 5-year warranty was specified for road work. Spain required 1 to 2 years. Normally, warranties must be secured by retainage or financial commitment totalling 5 percent of the contract amount. The Spanish government has required securities or "bonds" as high as 10 percent of the contract amount and stated that limit may go as high as 20 percent under some circumstances. Note: a "bond" in the European definition is not the same as the insurance instrument defined in the United States.

There appears to be a wide divergence of opinion across country boundaries and within individual countries regarding the value of warranty requirements. Some believe they have a positive, decisive influence on sustained high quality. Others seem convinced that quality would not be diminished if warranty requirements were eliminated. This belief is based upon the long-standing, very high standards of quality set forth in their design and construction specification requirements. The discussion of warranties in subsection 6.3 for each country illustrates the range of views in that country on this issue.

In response to questions regarding what specifically was covered under various warranty provisions, the answer in all countries was that contractors were responsible for materials and workmanship and all but routine maintenance unrelated to their actual work. (Routine maintenance included such activities as snow removal, roadside mowing, litter pick-up, and ditch- and culvert-cleaning.) These warranty provisions were rarely invoked.

Examples of possible contractor-required maintenance included repair of pavement ravelling, premature cracking, faulting, spalling, potholes, bleeding asphalt pavement correction, and wheel-track rutting. In addition, failure of structures or structural elements, premature rusting of steel, and spalling of concrete decks were cited as conditions that might be determined to be contractor responsibilities.

In most cases, failure of any work under warranty triggers an investigation to determine causes and assign responsibility. The result of this investigation determines whether the government or the contractor is obligated to pay for repairs or corrections.

2.4.4 Product Evaluation

The initial evaluation of products is based on compliance with specifications as measured by sampling, testing, inspections, and physical measurements. Follow-up evaluations are not uniformly made, but there are procedures in use to attempt to periodically measure and evaluate the performance of road surfaces and to determine maintenance needs.

Deflection measurements are used, to some extent, to determine appropriate timing for the placement of preventive overlays. This procedure is considered critical by some engineers because it indicates when structural upgrading is required before visible signs of failure appear. Effective preventive maintenance programs appear to be a key to the seemingly perpetual state of high quality of the pavements in Europe.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

- Major roads in Europe have been judged to be of high quality by American visitors, and this impression has been confirmed in detail by the highway engineers and administrators in the CATQEST group. The basis for this judgment has been the general condition, smoothness, and durability of roadway surfaces and the environmentally conscious beauty of major structures. It must be recognized that a high level of maintenance expenditure supports this system.

- The quality of roads in Europe, as elsewhere, is dependent on the resources necessary to construct and maintain them. European funding strategies for highway construction purposes vary. The "pay-as-you-go" approach uses funds allocated from the general treasury on an annual basis. The alternative is a system of substantial indebtedness with large interest payments and long-term pay-back provisions. The latter approach is dependent on toll collections to pay off the borrowed indebtedness.

- Base costs of fuel, as well as taxes on motor fuels, are very high in Europe compared to these costs in the United States. However, none of the fuel taxes are dedicated to highway construction and maintenance purposes. Such revenues flow directly into the general treasury for allocation to all government programs. The taxes on motor fuels also flow back out of general funds to pay for roads. However, it is estimated that the equivalent of about one dollar (U.S.) per gallon goes back into highway construction, which is significantly higher than in the United States.

- The four countries reviewed endorse industrywide innovation in the design and construction of highway facilities. On many projects, they actively encourage contractors to submit alternative proposals with options including new technologies. However, contractor opinion seemed to be that the basis of selection was generally lower price rather than higher quality.

- Strong emphasis is placed on the need to construct highway projects from the bottom up. This means using highly stable materials in the roadbed or pavement foundations and providing effective drainage measures for the pavement substructure.

- As in the United States, contractors are responsible for constructing projects in accordance with contract requirements, and they normally have a genuine desire to do so. A less idealistic factor that motivates contractors to perform is the financial loss that they could incur by producing poor-performing facilities. In Europe, such losses could result from the forfeiture of warranty securities or the denial of future contract awards.

- On nearly all projects, contractors are required to provide a quality control plan, which may include the use of certified quality control personnel.

- In some of the countries, contract awards are often made on the basis of best bid and not necessarily the lowest bid. However, it is important to understand the actual contract award processes involved when attempting to make a comparison between Europe's best-bid procedures and the US low-bid practice. There appear to be a few reasons why the low bid is not always selected for contract award in Europe. There are few prequalifying restrictions placed on potential bidders under the open competitive procedure. As a result, it is not uncommon to receive as many as 30 or 40 bids on a single project. All of these bids then undergo a pre-award evaluation and screening process in which many are eliminated on criteria other than cost. Thus, some of the lowest bids are not considered to be in the best-bid category and accordingly are not further considered for award. Bids that survive the initial screening processes are subject to further evaluation. In most cases, the lowest bid from this short list will also be considered to be the best bid, and the contract will be awarded accordingly. The inclusion of solicited or unsolicited alternative proposals submitted with required bid proposals *may* also be determined to constitute the best bid. In such cases, the award *may* be based on this best bid even though it may not be the lowest bid.

- High-quality pavement surfaces, particularly asphalt pavements, are achieved by constructing either to full design-life standards or by constructing to a lesser standard initially and providing planned, periodic surface overlays during and beyond the design-life analysis period.

- Two key elements to consistent, long-term quality of the pavements appear to be the commitment to (1) high-quality pavement substructure design and construction, and (2) effective, efficient, and aggressive preventive maintenance programs.

- There is a clear separation of responsibilities and accountability between owners and contractors in the construction and administration of projects. This separation is considered essential, even though a cooperative, nonadversarial association seems to exist in the countries studied. This separation of responsibilities is illustrated by the general practice of basing final acceptance decisions on the governments' sampling, testing and inspection programs rather than on contractors' quality control sampling and testing data.

3.2 Recommendations

Recommendations arising from the CATQEST studies are as follows:

1. Some key elements in highway design that led to Europe's high road quality were found to be: longer design life, excellent preventive maintenance, use of staged construction with a strong pavement base, and the use of life-cycle cost goals. Full application of these techniques in the United States

requires the political will to provide adequate funding for better roads. Until an increase in funding is available, it is recommended that FHWA and AASHTO work with industry to (1) promote road quality research and development, (2) reduce regulations that restrict such improvements, (3) emphasize life-cycle costing of projects, (4) allocate more funds to preventive maintenance, particularly on the National Highway System, and (5) emphasize the need for good quality in all aspects of planning, design, and construction.

2. Quality control and quality assurance (QC/QA) approaches are widely used in Europe. To overcome resistance to their wider use in the United States, agencies should establish and require contractor QC/QA plans. This assumes fair and reasonable standards and requirements, jointly developed by agencies and industry. Total quality management (TQM)-type programs should be established at all levels and for all participants. While owners should remain responsible for acceptance of work, more contractor quality-control results should be used to document the quality for acceptance.

3. European techniques in positive environmental treatments have much to offer the United States. Europeans have good ideas about surface drainage collection, pavement noise reduction, landscaping, flora/fauna bridges, architectural treatments, and positive community impacts. Although funding concerns will limit U.S. applications, AASHTO and FHWA should actively promote such new technologies here.

4. An alternate bid system is often used in Europe to encourage contractor innovation, compared to the usual U.S. practice of awarding a fixed contract to the lowest responsible bidder. Based upon good results in Europe, it is recommended that U.S. agencies consider using a form of "alternate proposals" within the low-bid framework. Emphasis on and acceleration of the value engineering concept by both the agencies and contractors, which permits alternatives to be presented after the award, is an excellent means of stimulating contractor innovation. Other components with defined guidelines for alternatives, for example, quality, can be published in the invitation to bid.

5. The concept of value engineering (VE), as defined in the United States, is not extensively used in Europe. It is currently being promoted in the United States, but its use in design and construction should be expanded. The effectiveness of the VE program could be improved by encouraging its use on construction projects by allowing contractors to submit alternate approaches that are equal or superior. States not currently using VE in design or construction need to reconsider their position.

6. Europeans seem to have reduced owner/contractor conflicts with closer coordination. While the United States is a more litigious society, progress can be made by promoting the "partnering" concept, by better design reviews, by encouragement of more designer and contractor input in design and construction, and by use of

alternative dispute resolution (ADR) mechanisms.

7. Europeans seem to be more successful at getting enhanced R&D on new products and methods implemented by closer industry-government cooperation. In the United States there is more independence, so greater efforts need to be made. Some recommended approaches are promotion of the Hi-Tech Center technology transfer concept by FHWA and AASHTO and consideration of making greater use of Regional Centers and academic institutions.

8. German and Austrian training programs for contractors' and owners' staff offer ideas for improving work force training in the United States. The United States now has only limited on-the-job (OJT) training programs and a few union programs. It is recommended that a formal construction training program be established in the United States, perhaps as a joint government/industry construction training institute.

9. The uniform performance measures approach used in France may not be feasible in our country because of the greater degree of state independence here. However, it is recommended that a "quality level index" be used both for acceptance of projects and as a long-term measure of performance on the National Highway System.

10. Design standards can include catalogs of standard pavement designs. It is recommended that development and use of higher pavement design standards be considered for the National Highway System.

11. Existing U.S. contractor prequalification programs could be improved by developing objective criteria similar to the international ISO 9000 quality assurance certification framework. Special consideration for small businesses and new businesses should be included. A study of how an ISO 9000-type concept could be introduced into the construction program should be initiated.

12. In Europe there is considerable national planning for new facilities and additions, while in the United States the approach is mandated Statewide planning processes. It is recommended that more national leadership be provided through establishment of a national plan with realistic means provided for its completion and maintenance. Approval of the National Highway System with adequate resources to maintain and enhance the system is a comparable approach.

Somes characteristics of European contract administration are *not* recommended until further evaluation has been completed:

1. The "best-buy" approach has been successfully used in Germany, France, and Spain, but because of our current laws and culture, it is not recommended for use in the United States at this time.

2. Despite some earlier impressions, it was found that the combined design/build approach is not extensively used in Europe.

Consequently, the findings of the CATQEST study do not support a recommendation regarding the use of the design/build concept. However, continued evaluation of the concept on an experimental basis should be considered.

3. The frequent use of guarantees or warranties in Europe was determined *not* to be the driving force behind quality. High levels of investment and high standards of design and construction specification requirements form the foundation of European quality. Although the findings of the CATQEST study do not support an extensive movement to the use of warranties at this time, it is recommended that this issue be studied further. While such study is under way, performance improvements should be made in the United States by greater emphasis on higher design standards, quality control/quality assurance, tougher enforcement of performance-related specifications, rapid-result testing, and prequalification of bidders.

4. COUNTRY SUMMARY—GERMANY

4.1 General Background and Organizational Structure

The Federal Republic of Germany includes 16 independent "länder" or "States," totaling 365,000 km² (140,700 mi²) in area. The population is approximately 80 million, resulting in a population density of 220 people per km² (580 per mi²).

The individual States have their own constitutions and laws pertaining to such matters as education, communal organizations, and police. They also have extensive administrative authority and can enforce most of the Federal laws as well as State laws.

Federal law provides that the States shall function as "agents of the Federation" in the construction and administration of the Federal trunk roads. Currently, the Federal Trunk Roads System includes approximately 10,700 km (6650 mi) of Federal motorways (U.S. interstate equivalent) and 40,250 km (25,000 mi) of Federal highways (U.S. primary roads equivalent). In performing the agent function, the States are controlled by Federal regulations and policies covering all aspects of project development and construction.

The Federal Ministry of Transport is the federal arm of government that has overall authority and responsibility for administration of the multimodal transport systems in Germany. Under the Federal Transport Minister, there are directors-general who lead each of the different modal transport agencies, and, under each of the directors-general, division chiefs lead the major organizational functions within the specific transport modal agencies. The basic organization of the Road Construction Agency starts with the Director-General for Road Construction. Under the Director-General are division chiefs for planning, budget, general construction contracts, technology, and research and development.

The central function of the Directorate-General for Road Construction is, perhaps, best described in a briefing paper prepared by the Director-General's office and is paraphrased below:

> The central function of the Directorate-General, Road Construction, is the construction, maintenance, development, and improvement of the Federal trunk road network. At the time, this comprises approximately 10,700 km of Federal motorways and approximately 40,250 km of Federal highways. Structures (bridges, tunnels, retaining walls) and the motorway restaurants, service areas, and petrol stations also fall under the responsibilities of this Directorate-General. The main emphasis, at present, is placed on the creation of equivalent traffic circumstances on the Federal trunk roads of the new States (formerly East Germany).
>
> In accordance with the Basic Law, the States build and administer the Federal trunk roads on behalf of the Federation. The Directorate-General for Road Construction is responsible for coordinating the efforts of the States, and the objective is to guarantee

a safe and efficient Federal trunk road network in all parts of Germany.

The Directorate-General, Road Construction, develops the requirement plan containing the concept of further development of the Federal trunk roads. Because of its political importance, the requirement plan has to be adopted by the Deutsche Bundestag (the Federal Parliament).

The Directorate-General for Road Construction does the following:

1. Develops the construction programs for the Federal trunk roads and administers the road construction budget.

2. Elaborates regulations, traffic technology, and general guidelines for the construction, design, and equipment of the Federal trunk roads.

3. Provides for an appropriate consideration of environmental concerns (e.g., the protection of the population against noise and exhaust gases), nature conservation, and urban planning.

4. Spends considerable funds for research work and studies on transport economy, cooperating closely with the Federal Highway Research Institute in Bergisch Gladbach (road construction and traffic technology), which it also supervises.

Appendix 10.1 contains several photographs of German construction projects. Figures 1 and 6 demonstrate how the Germans incorporate environmental responsibility into projects. Figure 1 shows a retaining wall that prevents ground slippage onto a highway while at the same time checking erosion. Figure 6 illustrates a prototype highway surfacewater collection system. The system also treats the water before releasing it back into the environment. Figures 3 through 5 show an autobahn in various stages of construction. They contrast new construction with that of an original autobahn of 1926, shown in Figure 4. Figures 7 through 9 show a concrete highway paving process. Figure 7 shows how an innovative separator fabric technique provides additional layer protection. Figures 8 and 9 illustrate the spreading of zero slump (bottom layer) and finish concrete layers respectively. A sample of bridge construction is shown from the former East Germany in Figure 11, which emphasizes the cantilever form supports, constructed without vertical falsework.

4.2 Highway Program and Investment Levels

The Federal Minister of Transport issued a Federal Traffic Infrastructure Plan in 1992 that identified a total Federal trunk roads expenditure requirement of 232.5 billion deutsche marks (DM); approximately US$146.5 billion for the period 1991–2010, distributed as follows:

Main (new) construction items
DM99.6 billion (US$62.7 billion)

Replacement investments, structures, external construction agents, etc.
DM91.8 billion (US$57.8 billion)

Operations, maintenance, and misc.
DM41.4 billion (US$26.1 billion)

The 1993 investment for these programs is DM10.5 billion (US$6.6 billion). Approximately 20 percent of this total is earmarked for such uses as operations and maintenance, which are considered "noninvestment" expenditures in the terminology of the planning report. The planning report also indicates an upward trend in the noninvestment and "other than main construction items" and a resulting downward trend for main construction items.

This trend portends a shortfall of funds needed for main construction and, accordingly, a need for investment-level increases if the needs identified in the 1992 Traffic Infrastructure Plan are to be accommodated. The Federal Republic, in recognition of this situation, is looking at a two-pronged strategy to mitigate the funding shortfall.

The first approach is aimed at such measures as privatization and greater use of toll roads. Serious consideration is being given to conversion of existing free roads to toll roads. It appears that prospects for such conversions are quite high, provided an efficient toll-collection system can be installed. The authorities believe that a system that does not require stops and does not cause traffic back-ups will be critical to any conversion approval. They are investigating electronic systems now in use, and they seem particularly interested in Oklahoma's Pike Pass System, currently in operation.

A second approach to the funding/investment situation is to reduce front-end outlays for the pavement structure. Apparently, there is some sentiment in higher levels of government that quality, as related to pavement design life and standards, is too high and that it might be in the public's interest to reduce existing standards.

Serious consideration is being given to reducing structural pavement design life to 5–8 years in the former East Germany. Critical needs exist in this area for immediate improvements in the road systems. This strategy could be considered "stage construction," which would result in more kilometers of roads of high serviceability placed in service at an earlier date than if the standard design-life and pavement structure standards were constructed initially. This concept is not unlike that used in the construction of many miles of bituminous-surfaced interstate highway projects in the United States.

In the final analysis, it appears that the Federal Republic of Germany faces the seemingly universal problem of too little money to accomplish their current and projected roads needs. Like other governments, both national and local, Germany is aggressively seeking solutions to this problem.

4.3 Project Development and Design

4.3.1 Life-cycle Costing

Germany does not formally or fully utilize life-cycle costing as we understand the procedure in the United States. The normal project development procedure is to forecast traffic for 20 years and use the 10th-year traffic projection for benefit/cost analysis. The economic (cost) calculations are based on a 20-year life with no significant upkeep or maintenance costs.

It should be noted, however, that a lump-sum amount of funding is set aside or provided in the budgeting process for upkeep and such maintenance as may be required during the 20-year life cycle.

User costs in the form of delays, more fuel usage and vehicle wear-and-tear are not specifically addressed or included in German cost analyses. These factors are considered to be adequately, if not specifically, accounted for in the general philosophy to invest heavily in the initial construction, assuring long-term durability and little maintenance, and to work very quickly when repairs are needed in order to minimize road user costs due to delays. Road user costs, including delays, *are* used in benefit/cost ratio analyses to rank or prioritize projects for advancement to the construction stage.

Project cost predictions procedures used in Germany did not indicate a significant advantage of one type of pavement over another. Under conditions where prolonged, elevated ambient temperatures and very high truck-traffic volumes are expected, road designers expect better performance from and lower life-cycle costs for concrete pavement, and they would normally select that material. On the other hand, asphalt pavement is generally less expensive to construct initially, is easier to repair when repairs are necessary, and is likely to perform better in mountainous areas where prolonged freezing is common and the traffic is lighter. Accordingly, asphalt pavement is used more frequently than concrete when all factors are taken into consideration.

To summarize, the Germans believe that, if properly designed and constructed, there is no significant benefit/cost advantage of one pavement type over another for the most prevalent conditions in Germany, but that, under certain circumstances mentioned above, there are advantages of one type over the other.

4.3.2 Project Development Constraints

Community and environmental issues are major factors contributing to a very lengthy planning and design process. Typically, these processes require 10 to 12 years from initial project-planning to start of construction. Legislation is pending to remove many existing approval steps and reduce the project development period by about 50 percent.

4.3.3 Design Parameters

Structural design of pavements is based almost exclusively on truck-traffic volume and normal speed of mixed traffic on a given route. Trucks are recognized as the major source of wear that the pavement structure must be designed to withstand. Recent changes raised legal load limits to 11.5 metric tons (mt) per single axle to conform with EU standards, making the truck-weight factor even more significant. Speed of normal traffic, while not a factor in pavement structural deterioration, is a matter of serious concern because of the safety problems generated whenever lane or section closures are required for maintenance or rehabilitation purposes.

In Germany, one basic pavement design policy significantly contributes to the long-life low-maintenance of roads. This policy is to provide a high-quality well-drained sub-base material of considerable thickness or depth, directly under the base course of the pavement structure. The quality and thickness of this sub-base layer is apparently determined primarily on the basis of experience and on economic availability of good-quality granular material.

Older autobahns (motorways) were designed with narrower shoulders, steeper side slopes and narrower clear zones than used on the U.S. interstate highway system. This would suggest that these safety-related amenities were not considered as cost effective as added pavement structure, and, when it came to trade-offs or competition for the available money, long-term pavement durability won out.

Germany has recycled old concrete and asphalt pavements and a variety of other solid-waste products for many years on a voluntary, experimental basis. However, for the last 2 years the recycling program has been mandated. Research is continuing in this field in an effort to identify new materials and applications adaptable to recycling.

4.3.4 Use of Design Consultants

There is a shortage of civil engineers in Germany. It is particularly pronounced in the eastern part of the country, where consultant engineers are utilized extensively by all levels of government. In the West, government designers are used almost exclusively at the State and Federal levels, and consultants are commonly used at the local or community level. Consultants are selected on the basis of technical competence criteria for the specific services required. Except for unusual circumstances, consultants are compensated using a common fee schedule. They are liable for their errors in design and plans and for the related consequences. They are required to carry up to DM1 million (US $630,000) liability insurance.

4.3.5 Construction Contractor Involvement

Contractors rarely get involved in the project design phase, except under the design/build concept (specification of works with performance program). This concept has been rarely used in Germany. A pilot design/build project was recently undertaken, but Federal Government officials believed the disadvantages outweighed the advantages on this project. Disadvantages cited include the strain on the bidder's design capacities for preparing the bid and the difficulty and amount of time required to evaluate proposals and to actually get from the planning to construction stage. There are no plans to initiate other such projects.

4.3.6 Design Quality Control

Design quality control normally consists of detailed reviews and checks by State and Federal engineers for technical accuracy and for compliance with governing standards and regulations. Plans are considered to be consistently of high quality. Constructability reviews do not appear to be part of the review process in Germany.

4.4 Contract Award Procedures

4.4.1 Bidding/Award Types

Three procedures are used to award contracts. It should be noted that German budgetary regulations require in principle that open invitations to tender be carried out, unless an exception to the provisions is justified (see 3. Direct awards, below).

1. Open invitations to bid. This is the procedure most often used in Germany, whereby all projects are widely announced throughout the country. In the case of contract awards under EU agreements, a notice must also be published in the official *Journal of the European Community* when the estimated value of the project is US$5 million or greater.

   In either type of procedure, interested parties, worldwide, are free to submit bids. Bids are evaluated by subjective and objective criteria, including bid amount, technical adequacy, scheduling, and overall quality of the bid. Following this initial evaluation, a short list is developed for further evaluation. In most cases, it appears that the lowest bidder from the short list is awarded the contract. This is not the low-bid system as practiced in the United States. The option does exist, and is invoked from time to time, to depart from the lowest bid, if another is clearly the best. In the German system it is sometimes difficult to determine who the true low bidder is due to the side-offer system.

2. Selective invitations to bid. Under this procedure, which is used for large projects, the orderer selects a minimum of three and a maximum of eight competent, efficient, and reliable contractors known to the orderer and invites them to bid.

3. Direct awards. In this case generally only one or two candidates are invited to bid. The exceptional circumstances under which a selective invitation to tender or a direct award procedure may be undertaken are specified in Federal regulations covering tendering and performance stipulations in contracts for construction works (construction contract procedures—VOB).

Side-offers (alternative offers), which apply to all three forms of bidding, are offers to perform work different from or in addition to that specified in the bid document. A side offer actually amounts to an alternate, which is attached to the regular bid. This procedure seems very similar to VE proposals in the United States. One difference is that side offers are submitted along with the regular bid instead of after the contract is awarded, and, accordingly, can be an influencing factor in selecting a bid for award. The Germans believe that side-offer procedures inspire innovation, and they encourage their use. The selection or award is based on the qualifications of the bidder, the quality of the bid, and the bid price.

Bids are evaluated according to several criteria, especially technical and economical quality. The contract is awarded on the basis of the best (most acceptable) bid. Actually in almost all cases the lowest bid is awarded, unless side offers play a role.

The essential elements of German public agencies' tendering and award procedures may be briefly summarized as:

- Strict requirement of free competition.
- No discrimination.
- Bid opening date.
- No negotiation on side bid amount or bid contracts.
- Evaluation criteria related to specific subject.
- Strict cancellation procedures.
- Careful evaluation of side offers.

4.4.2 Road User Cost and Time Considerations

These factors are normally considered on the basis of historical data and on special conditions such as criticality of road closure times as a safety consideration. Such considerations could influence the award-selection decisions.

4.4.3 Prequalification Procedures

Contractors are not prequalified in the same sense as the term is used in the United States. However, it would seem that a form of prequalification is used in the selective invitation and direct award procedures, where it is predetermined which contractors are eligible to compete for particular contracts.

4.4.4 Subcontracting Procedures

Subcontracting is permitted but not widely practiced. The government contracts directly with the prime contractor and holds that contractor solely responsible for delivering or producing work in accordance with requirements.

4.5 Construction Quality Control

4.5.1 Specifications

In Germany, as in the United States, there appears to be some inconsistency in interpretation of the meanings of terms such as "methods," "end results," and "performance-based" specifications. Semantics, therefore, can be a problem in labeling specification types by simple one- or two-word descriptions. Germans generally consider their specifications to be both end-result and performance based. That is, their standards and specified quality parameters are designed and prescribed specifically to assure desired end results and levels of performance.

They believe that, if these prescribed and specified requirements are strictly enforced, the desired end result and the level of performance will be assured. Actually, the German specifications are not unlike those in general use in the United States and, in U.S. terminology, are considered to be a combination of methods and end-result specifications. For example, in concrete for paving they normally specify such things as water/cement ratio, minimum cement factor, and mineral aggregate properties. The end result of this prescription or "method" must then meet specified strength and smoothness requirements. The owner will validate mixture designs created by the contractor to assure they meet the end result required in the specifications. Asphalt pavement specifications are similarly formulated.

Germans emphasize that cooperation between government and industry results in clear, unambiguous, and binding specifications that are agreed to by both parties.

4.5.2 Contractor Quality Control

Contractor quality control is normally referred to as "self monitoring": the contractor controls the work done by his own personnel. It is possible that the government will use additional professional engineers to control the quality of the work. A primary element of project quality control is the sampling and testing program. For materials, quality control by the contractor is mandatory and could include the quality control performed by a professional engineering firm.

In addition to the quality-control contract requirements, there are incentives built into the system which further encourage contractors to exercise good quality control and produce a high-quality product. Substandard work may lead to exclusion from future contract awards. Further, contract warranties are required on all projects. Essentially, contractors are required to provide a bond or security to guarantee their work for generally 2 to 5 years and to repair or rebuild deficiencies during the warranty period.

4.5.3 Contractor Work Force Training and Certification

Project superintendents appointed by the contractors are required on all Federal projects, and they must be qualified professional engineers. Construction workmen are basically trained by the individual contractors in a 3-year, on-the-job apprenticeship program. In each year of the program, associations of the construction industries may pay for selected additional courses for the apprentices. Successful completion of postapprenticeship courses is a requirement for advancement to supervisory levels within a contractor's organization, including such positions as foreman on sites or other relevant management positions.

4.5.4 Incentive/Disincentive Provisions

Incentive/disincentive contract clauses are used infrequently. Incentives are more likely to be manifested indirectly by acceptance of side offers that may economically benefit both the government and the contractor. Occasionally, contracts will include a bonus for early completion. Disincentives, in the form of reduced payments for less than 100 percent compliance with contract specifications, are rarely used in Germany. The material or work is either accepted or rejected. Rejection results in removal and replacement at contractor expense. The contract documents are very clear and unambiguous in this regard.

4.5.5 Legal Issues, Claims, Partnering

There are apparently few claims and little litigation on Federal and State projects. This is considered the result of cooperation between industry and government in establishing rules and standards and in eliminating ambiguity in contract requirements. In the words of one of the German tour hosts, "Everybody understands and lives by the 'Bible'. It is the final word, so there are few disputes." (The "Bible" is actually the VOB or Federal Regulation, which is roughly equivalent to Title 23, United States Code, Highways, and Title 23, Code of Federal Regulations, Highways.)

Liquidated damages are rarely assessed, although there are contractual provisions

for doing so, when the contractor does not perform satisfactorily. The Federal Highway Institute is studying the issue of justifiable damage amounts for time overruns, as related to traffic delays, accidents, inspection costs, and other factors. The extremely low incidence of claims and litigation can also be related to the greater flexibility in the procurement system, which enables the government to limit the awarding of future work to less desirable contractors.

4.6 Quality Assessment and Performance Evaluation

4.6.1 Definition and Measurement of Quality

The Germans define quality simply as 100 percent compliance with contract requirements. The requirements are generally founded on basic regulatory and technical mandates and principles, and they are very clearly defined. Essentially, the desired quality is defined in contract documents in the form of designs, plans, standard specifications, and operations and administrative procedures. It follows that if all such elements of the contract are complied with by all parties concerned, the result is "quality." This quality is reached, if the conditions of the contract are properly met.

4.6.2 Quality Assurance Program

The two basic elements of Germany's quality assurance program are: quality control or self-monitoring by the contractor and independent quality assurance by the owner or Government. (Contractor quality control was discussed earlier and will not be repeated here.) The Government's quality assurance program includes verification-type sampling and testing that is performed either by Government personnel or by outside commercial laboratories under contract to the Government. Quality assurance also includes monitoring adequacy of the contractor's equipment, procedures and personnel.

Germany stresses the importance of a cooperative rather than adversarial relationship with contractors, to assure a consistent, high-quality product. However, Germans recognize that both the Government and the contractor have their own responsibilities and some divergent motivations. Accordingly, although contractors are required to have an acceptable quality control program, which is monitored rather closely by the Government, the Government does not use contractor test results for product acceptance. Acceptance is based on independent inspection, sampling, and testing performed by or for the government.

4.6.3 Warranties and Guarantees

Warranties are mandated by Federal law and are required contract provisions on all Federal and State projects. The warranty periods vary: 5 years for earth-moving and construction work, 4 years for roadway surfacing, and 2 years for most other construction items. If nothing specific is stated in the contract, then a warranty of 2 years applies, as established in the regulations.

Warranties are secured by bonds or financial institution securities totaling five percent of the contract amount. It must be

remembered that the definition of a "bond" is not the same as the understanding of an insurance instrument in the United States. Sixty percent of this security obligation is released upon acceptance of the project by the Government. The remaining 40 percent is held until the end of the warranty period, or is used during the warranty period to perform repairs of work covered by the warranty provisions.

The Government monitors the performance of the project during the warranty period in an informal and pragmatic manner. During this period, the Government can require the contractor to perform such repair work as it considers justified. If the contractor refuses to perform such work, the Government will have the work performed by another contractor or will undertake the work with its own forces. Such work will be paid for with the warranty bond or security deposit.

At meetings with the study team, both the Government and contractors professed satisfaction with the present system. However, under close questioning, both owners and contractors indicated that even if there were *no* warranty provisions, they would not accept or deliver a lesser quality of work. The owners stated that they would demand no less than full compliance with the specifications. The contractors stated that they would deliver equal quality because they had full confidence in the designs and because they wanted to remain in high standing and eligible to bid on future projects.

4.6.4 Product Evaluation

There does not appear to be a formal, required evaluation program in use at this time. Visual observations are performed on an informal basis, by Government employees during normal travel. These observations may lead to more detailed inspections of such distress-associated features as cracking, rutting, spalling, and other obvious forms of deterioration of surfaces. A considerable amount of long-term, gross research activity (or documentation of experience) appears to be going on to verify soundness of basic design, basic specification, and construction standards as well as to recommend any needed changes.

There is apparently little public input regarding performance standards. However, in the planning stages there is ongoing debate regarding the appropriateness of some current standards. Some argue that it would be better to reduce standards and improve or construct more kilometers of highways in poor condition than to build fewer kilometers to higher standards. This is particularly true in the new States in reunified Germany.

4.7 Summary Comments

Some practices and techniques used in Germany are similar to those used in the United States, with a few exceptions, as noted below.

- Side offers (alternative bids) are encouraged and are sometimes the deciding factor in award of the contract. The side-offer procedure encourages and stimulates innovation and can result in enhanced quality.

- Warranties are considered by some as a quality enhancement factor because

they provide a tangible incentive to maintain high-quality standards in construction, and because they discourage "cut-rate" competition.

An official of the Federal Ministry of Transportation addressing the issue of warranties or guarantees stated: "In the German view, the contractor's obligation to provide a guarantee has a decisive influence on the quality, because the later remedying of defects by the contractor usually is very expensive, and the contractor can eliminate such costs by doing good work to begin with." This official added, "The costs of the contracting authority for maintenance are reduced considerably by the guarantee period, because these guarantee periods are established at a duration that defects in performance often appear during this time period."

Several responders indicated that the depth of tradition and adequacy of design expressed in the VOB are a root cause of the comfort level between the contractors and the Government regarding warranties. The Government's financial commitment to quality makes possible the design standards and construction practices that form the foundation for high-quality pavements and structures.

- Cooperation between government and industry is cited as a definite requisite to sustained high quality.

- Strict adherence to and consistent enforcement of contract plans and specification requirements are essential to high quality.

- Within limits, the quality of any element of a highway project is proportional to the financial resource commitment to that element. This is reflected by earlier autobahn construction, in which heavy investments were apparently made in the pavement substructure and structure and lesser investments were apparently made on safety and environmental features.

  The situation may be changing on newer projects because of funding deficiencies and increasing demands for safer and more environmentally sensitive transport facilities. However, the Germans recognize that a stable high-quality roadbed is essential to a high-quality durable pavement structure. Accordingly, they do not intend to sacrifice the integrity of the roadbed or foundation in order to stretch available funds. As indicated earlier in this report, however, the thickness of pavement surfacing courses will probably be reduced during initial construction, in order to reduce front-end costs.

- The German construction industry is very serious and conscientious about training their work force on the merits of quality and have established a formalized training program. Companies are responsible for training, which they do via 3-year, on-the-job (apprenticeship-type) training programs. They also offer advanced training for foremen and superintendents, which can lead to engineering school. As a result, they believe they have a very highly skilled construction work force.

5. COUNTRY SUMMARY—FRANCE

5.1 General Background and Organizational Structure

The Republic of France is a nation of approximately 56,420,00 people (in 1991), a total area of 551,670 km² (212,000 mi²) and a population density of 102 people per km² (264 per mi²). There are 22 regional, political subdivisions and 96 metropolitan counties, an organization resembling the State/county structure in the United States.

The Ministry for Public Works, Transport, and Tourism is the central body with overall responsibility for national infrastructure administration. The Directorate of Roads, under this ministry, is responsible for road infrastructure. The Road Department formulates and implements the modernization and maintenance policy of the national road network, provides control of motorway concessionaire companies, and ensures that road infrastructures have consistency.

The 22 French regions represent the administrative level between the national Government and the 96 metropolitan counties. They do not have their own highway networks, but participate in the improvement projects on the national highway networks through 5-year State-region development contracts.

The General Council in each county is responsible for its county road network. It approves the funds for all construction, improvement, and maintenance works. The county public works directorates (DDEs) provide project management and contract administration functions for the State on the toll-free national road networks. They also perform maintenance and project management for the General Councils on most county road networks.

Concessionaire corporations are an important element of the management organization of the highway system. Such corporations have either a mixed capital structure shared between the Government and the local communities, or are privately owned. It is interesting to note that the only private corporation currently under operation on the interurban highway system received low interest, reimbursable bridging cash advances from the Government amounting to US$157 million, in order to help the short-term financing of the newly added highway sections.

The financial viability of the shared-capital concession companies has to be assessed in the very long term because of their inner cross-subsidization. [This cross-subsidization allows them to use additional resources coming in from highly profitable (highway) sections to support those that are financially poor because of low traffic, during the initial investment and the first few years of operation.] The fact that the Government is the main shareholder in these "mixed economy" companies in which the equity level is fairly low, does not influence their financial condition, since they have a private legal status and they have not actually received any subsidy whatever from the government since 1973, when the initial cash advances, used to subsidize the very first years of concessions were stopped.

It is clear that the concession concept is not a panacea, for it requires very long-

term financing, which results in compulsory high interest rates. However, it offers a way to finance necessary new constructions that the Government couldn't otherwise afford. This results in high-quality pavements and roadwork, completely disconnected from any Government budget constraint. The seven joint public-private concessionaire companies have a common prime construction managment and engineering office, SCETAUROUTE, in charge of preparing project designs and managing the construction work.

In addition to the concessionaire program and external services agreements with the region and county public works departments, the state directorate of roads has broad responsibilities for the establishment and operation of a comprehensive technical network. This network includes one central public-works research laboratory, one tunnel engineering center, and seven regional engineering centers, which include, among others, 17 regional public-works laboratories. All national highways and nonconcessionaire (nontoll) motorways are controlled directly by the state.

Appendix 10.1 contains several photographs of a French construction project. Figures 13(a) and 13(b) show a high bridge structure under construction, next to an existing similar bridge near Nantua. Figure 14 shows the same structure as Figures 13(a) and 13(b), but from a slightly different viewpoint, which includes buildings to show scale.

5.2 Highway Program and Investment Levels

Classifications and approximate lengths of the various road networks in France, as of January 1992, are as follows:

Motorways	8,041 km (5,000 mi)
National roads	28,255 km (17,557 mi)
County roads	354,000 km (219,971 mi)
Communal roads	526,000 km (326,850 mi)

The national roads master plan identifies the interurban motorways as the backbone of the national road network and calls for expansion of that network to over 12,000 km (7,440 mi) by the year 2010. This would include approximately 8,900 km (5,520 mi) of concessionaire (toll) motorways and approximately 3,320 km (2,060 mi) of freeways.

Overall, more than 60 billion francs (US$12 billion) have been devoted, over 5 years, to modernizing the national road network, excluding toll motorways. Financing sources for these investments are currently approximately 50 percent by toll motorway companies, 25 percent by the State and 25 percent by territorial communities. Revenues from State and territorial communities are derived indirectly from the general revenue from gas tax. It is important to note that

revenue from the older motorways enables the financing of new motorways on which there is insufficient traffic during the early years to be financially self-supporting.

5.3 Project Development and Design

5.3.1 Life-cycle Costing

The French use life-cycle costing based on an analysis period of 15, 20, and 30 years for national highways (30 years for rigid pavements). For the motorways, these figures are more likely to be 25 years for flexible pavements and 40 years for rigid ones. On bituminous-surfaced roads the French rely on a lower initial investment and a planned periodic overlay (stage construction) strategy as a basis for life-cycle costing. When life-cycle cost analysis is performed, it takes into account the cost of a heavy layer laid on top of the pavement after 25 years. It is very rare that a concrete pavement layer is ever broken up. (It has been done, but after significantly longer periods of time, 40 years or even more.) These stage construction overlays are done at 8- to 10-year intervals. It was not determined whether the planned costs always involved breaking up and/or recycling and replacing Portland cement concrete pavements at the end of the 20-year analysis period. However, an example was cited where this was the case.

User costs in the form of traffic delays and safety are given consideration in the design of motorways, but not in calculations for life-cycle costing analyses of other roadways. Primary efforts currently are directed toward value analyses; i.e., value engineering and improved design to optimize life-cycle costs of all of their roads.

5.3.2 Project Development Constraints

Environmental concerns are intensifying and have led to a number of expensive and time-delaying compensatory measures. These measures include collecting and treating fluids in case of accidental spills of petroleum products. The process for "taking land" for road and motorway construction involves a number of preliminary legal steps and extensive legal actions which are both time-consuming and expensive.

The State and concessionaires are also required to work closely with communities and the public to mitigate any adverse impacts the road may have on the aesthetics of the countryside and communities and on the sensitivities of residents. An example of this sensitivity recognition is the design and construction of high crossing viaducts at Nantua. Here a parallel, second structure was designed to be in the shadow of the first so that, when viewed from the valley floor and community, there appears to be only one viaduct. For all new construction, an environmental assessment has to be performed, and each project must be subject to a public inquiry, according to regulatory procedure.

In summary, it is apparent that the French are becoming increasingly protective of the environment and aware of the public's desire for aesthetics in their construction programs. Demands for enhancement in these areas result in an increased time period between project conception and completion of construction, as well as in increased costs. These are, apparently, trade-offs the French are willing to accept.

5.3.3 Design Parameters

Current French design parameters, standards, and quality upgrading of their roads were reviewed after the destruction of many of their paved road surfaces in the winter of 1962-63. During that winter and following spring, severe and prolonged freeze/thaw cycle conditions, coupled with inadequate control of truck weights, resulted in almost complete destruction of pavement surfaces on 40,230 to 43,450 km (24,940 to 26,940 mi) of the national road network. In response, the French began an extensive review of their design parameters and procedures and started developing a catalogue of standards, beginning with sub-base quality, thickness, and drainage requirements. This has also led to the implementation of a program for strengthening pavement that covered up to 24,000 km (14,900 mi) of national roads.

At the present time, pavement design life is stated as 20, 25 and 40 years for flexible, semi-rigid and rigid pavements, respectively. However, it should be recognized that the overall pavement life cycle is based on a 20-year analysis period. Accordingly, it would appear that, in the case of flexible pavements, the 15-year stated design life would equate to what might be considered a first stage of construction in many projects in the United States. Also, it seems that the French recognize the need to renovate or overlay their asphalt pavements every 8 years or so, even if the basic pavement structure is sound. Normal wear from such things as studded tire abrasion, weathering, and wheel track rutting require such overlays to keep the surface in a safe and serviceable condition.

The French now allow single-axle loads of 13 metric tons (mt) (14.3 US tons) maximum and use this figure for pavement design. They anticipate reducing this legal-load limit to 11.5 mt (12.7 US tons) to conform to EU standards. They will probably continue to base their pavement designs on the heavier loads, in recognition of current and probable continued difficulties in legal-load enforcement. Truck traffic multiplied by axle loads gives a figure that is considered the major factor in structural pavement design. On that basis, concrete pavement is usually justified for use on motorways, but not on other roads. The French consider the initial investment cost of concrete pavement to be too great to justify its use on 95 percent of the road network.

One of our French hosts indicated that 60 percent of France's planned investments for pavements will be for construction and 40 percent for maintenance. The French, through their extensive research and innovation efforts, have developed a durable open-graded, free-draining and noise-suppressing asphalt wearing surface. Because of its apparent success, it is starting to become an important development. The high quality of the road network is the result of the design policy associated with preventive maintenance, the selection of quality materials, and the quality of the work implementation.

The large highway contractors' engineering staff, along with the engineering staffs of the oil companies, have contributed to the pavement design through the use of proprietary designs, which were submitted in competition on toll roads and major highways as a part of

the warranty requirements, or in developing the best bid. Research and cooperative innovation continue to receive high emphasis and visibility in France, and it is believed that these are the keys to success and to the high quality of French road networks.

5.3.4 Use of Design Consultants

Private consultants are not extensively utilized in designing roads on the French national and county networks. The toll roads are all designed for the concessionaires and state by SCETAUROUTE. An exception is the one privately financed concessionaire, in which the engineering staff of the major contractors performs all engineering for that concessionaire. The counties and especially the communes can call for proposals from either or both private consultants or government engineers to perform required engineering on their local roads. Approximately 40 percent of this work is contracted out to consultants.

5.3.5 Construction Contractor Involvement

Construction contractor involvement in design of nontoll facilities and routine projects is generally limited to "value engineering" or "alternate bid" approaches. On some major projects, construction contractors in France have their own design and research staffs. As discussed earlier, SCETAUROUTE designs most of France's toll roads. The significant contractor involvement in road and structure design is consistent with the high emphasis on industry-state cooperation, research and innovation. A striking example of contractor design is illustrated by the prestressed, segmental box girder structures of the Sylans viaduct on the A40 motorway near Nantua [see Figs. 13(a) and 13(b), Appendix 10.1].

5.3.6 Design Quality Control

The French are evaluating the ISO 9000 certification concept and expect that European Common Market requirements may eventually include ISO 9000 or something similar. There was little direct discussion on this subject. However, it is evident that French engineers enjoy a high level of respect for their expertise, skill, and academic qualifications. Their highly acclaimed structures, high-speed rail lines and other innovations stand as monuments to overall quality as judged by unobtrusive aesthetics as well as by facility and structural soundness. In keeping with its high priority on cooperation and innovation, the national government encourages the use of value engineering on projects and is seeking agreements with the 22 regions to perform value analyses of proposed projects in their jurisdictions. This activity appears similar to the public hearings and alternative studies practices conducted early in the project development and design stages in the United States.

5.4 Contract Award Procedures

5.4.1 Bidding/Award Types

There are nine large, vertically integrated construction companies that perform 80 percent of the highway and bridge work in France. These companies have offices spread throughout the country. They perform work of all types, ranging from small items, such as sidewalk construction, to the large highway and bridge

construction projects, dams, tunnels and shipping facilities. These nine large companies, for the most part, appear to be part of larger conglomerates that include such other businesses as banking and petroleum which, in turn, have very close ties with and partial dependence on the State for their successful operations.

Project plans and specifications establish the scope of work of the project and define, in detail, the specific items of work. These plans and specifications are the documents upon which the basic contract bid is made. There are three bidding processes used for highway and bridge construction projects.

1. Open public bidding. This is the method used most often and is generally for projects that involve routine work. Standard specifications and contract provisions for these are well known in the contracting community. These projects are publicly advertised in authorized French public media publications for 21 days. Projects over US$5,000,000 must be advertised throughout the EU. Approximately 90 to 95 percent of the contract awards are based on the "best bid" and not the low bid. Cost is only one of several factors in determining which is the best bid.

2. Restricted invitation to bid. For projects that are more complex than the routine type and that require special expertise, experience, or equipment, a general announcement is made in the media inviting contractors to submit their qualifications statements. The Government then will evaluate the submissions and invite the best qualified to submit bids. Bids received will be evaluated for quality and price, and a selection for award will be made.

3. Direct negotiation. On work of a specialized or emergency nature, contracts can be negotiated directly between the Government and the contractor. This type of contract is limited to very small projects.

Contractors may submit alternate bids for the use of new or improved materials, alternate methods of construction, new equipment or any other factor that may improve quality or save project costs. To be considered, alternate bids must be accompanied by a basic bid in accordance with the requirements of the advertised plans. The contract is awarded on the basis of the "best/most acceptable" bid of all the basic and alternate bids submitted, as determined by a multilevel government review procedure. All reviewers must agree with the ultimate award decision, and the review analyses must be documented in report form. The successful contractor will be the one who submits the "best/most acceptable" bid and not necessarily the one who submits the lowest bid.

An unsuccessful bidder who is dissatisfied with the award may take his or her case before an administrative board of review, which is an internal Government review board. The reports of the reviewing officials are then reviewed by the board. The board is obligated to hear complaints and to review all the reports prepared by the bid review officials. These reports must contain justifiable reasons for awarding the contract to one contractor over the others. A severe fine or prison

sentence can be imposed on anyone who acts dishonestly or shows unsupported partiality in the award process. It should be noted that contract award protests against the Government are rarely filed.

5.4.2 Road User Cost and Time Considerations

Road user costs are not generally considered in the basic plans and specifications for contracts. However, these factors are given appropriate consideration when applying liquidated damages to contracts that have exceeded the allowed contract time period. The savings in road user costs, the inconvenience to the traveling public and the impact on safety- and accident-related costs may be addressed in alternative bid proposals. This is often a major factor in the selection of the "best/most acceptable" bid for award.

5.4.3 Prequalification of Contractors

With the exception of the very large projects, there are no specific contractor prequalification requirements in France, because there are a limited number of contractors who do most of the work, and they are all well known to the government. In the words of a Government official, "We are a small country and all know one another. We know the capabilities and qualifications of all of the contractors; therefore, there is no need to go through a formal prequalification process."

In addition, a contractor stated that "we perform work as specified because we want to continue to get jobs from the State." Government personnel concur with that statement and indicate that, if a contractor fails to perform the work in an appropriate manner or performs to lower-than-specified standards, the Government can reject the contractor's offers on future projects, until the Government believes that problems have been corrected and his or her "ship" is again in order.

5.4.4 Subcontracting Procedures

There is little subcontracting performed because of the capabilities of the nine large companies who do most of the work in France. However, it is possible that, on some projects which include very specialized items of work outside the normal capability of the prime contractor, a subcontractor who has the necessary qualifications to do the specialty work will be engaged. Furthermore, major contractors also use small subcontractors on the requests of the local Governments wishing to maintain local employment. Subcontractors must be approved by the Government on a project-by-project basis before they can begin work on Government projects.

The same contracting procedures used by the Government on direct, Government-controlled and administered projects also apply to contracts administered by concessionaires or toll companies, primarily because the Government is a 51 percent shareholder in those companies and owns the toll road.

5.5 Construction Quality Control

5.5.1 Specifications

Combination prescriptive and end-result specifications are found in the *Cahiers des Clauses Techniques Générales (C.C.T.G.)*,

the General Technical Clause Books. These books are written under the consultation of all individuals involved (owners, prime contractors, and subcontractors) to impose or recommend specifications. It is then the contractor's responsibility to produce products meeting all specified properties. The contractor's methods, equipment, and construction techniques used to produce this result are left to the contractor's own devices.

A modified version of this type of specification requires the bidders to include in their offers a bidder-formulated quality assurance plan. The specific steps to be taken for internal quality control and quality assurance are determined by the bidders, and it is their responsibility to adhere to the requirements they have formulated and included in the bid offer. These steps are performed in two phases, one that is internal to construction and one that is external, performed under the authority of an agency that does not belong to the job site's own organization. In a sense, this is a "methods" specification, but one in which the bidder prescribes the methods.

5.5.2 Contractor Quality Control

In addition to this specified requirement for a quality control plan, the contractors must provide qualified personnel to perform all sampling, testing, and inspection needed to comply with their plan. An exception is that small contractors, who may not have the resources to maintain adequate, full-time sampling and testing capability, are given the option of paying a servicing company, including Government regional laboratories, to do these functions for them.

Under either system, the owner agency independently performs quality assurance, verification-type sampling, testing, and inspections. Both contractor quality control/assurance and the State verification quality assurance programs contain minimum sampling and testing requirements. It was indicated that the nine large companies discussed earlier all have ISO 9000 concepts and standards under consideration.

5.5.3 Work Force Training and Certification

Technical qualifications, including certification, are required for engineers and technicians responsible for administering the quality control/assurance programs. The French stress the importance of professional competence of the contractor's project administration personnel and also the importance of skill and competence of workers who actually construct the project. Each organizational element and each person in the contractor's work force is held accountable for the quality of his or her own work. If such work does not consistently meet high-quality standards, the workers and supervisors face demotion to a lower skill level position or even discharge.

5.5.4 Incentives and Price Adjustments

There are no disincentives or price reductions for noncompliance with specifications. In theory, the French replace or reject noncomplying materials or work. However, beliefs were expressed in our meetings that they were too relaxed in applying this theory and that their specification tolerances were sometimes

too liberal. They are taking steps to tighten up both the tolerances and specification enforcement.

Serious roadway or surface failures that require early, extensive maintenance are infrequent. When they do occur, they are almost always determined to be caused by failure to construct in accordance with technical requirements and regulations.

There are no incentives in the form of bonus payments for early completion or for performing at a higher quality level than required by the specifications. Liquidated damages can be assessed for late completion. In the case of toll facilities, the amount of damage is to be determined on the basis of estimated lost toll revenues. However, this procedure has never been used.

5.5.5 Legal Issues, Claims, Partnering

There seems to be very little litigation between contractors and owners on road projects. This fact is attributed primarily to the clear requirements and procedures used by the State in their claims-review processes. Usually, when disputes arise, they are resolved at the project level and rarely go to the courts for adjudication. Another factor cited for the low incidence of litigation is the cooperative nature of the state-industry relationship in working toward the common goal of cost-effective high quality, starting with specifications and plans preparation. Stated another way, the close relationship between Government and contractor and the subjective bid award system minimizes litigation.

5.6 Quality Assessment and Performance Evaluation

5.6.1 Definition and Measurement of Quality

At a seminar on toll highways held in Paris in October 1992, a French road official discussed the term "quality":

> It is important, first of all, to realize that the term "quality" does not refer to any particular degree of excellence or performance, but, rather, to satisfying needs, and only that. This means that if a Trabant automobile is needed, or even a Peugot 205, no attempt will be made to get a Mercedes.
>
> The client [government] defines its needs and its objectives: the durability of the road surface in view of a decrease in maintenance costs, special environmental protection measures in this very sensitive sector, etc. It is the quality of *usage* that needs to be addressed in defining specific work to be done. These needs are converted into contractual requirements that may be measurable, in which case they are performance specifications, and, in the case of resources, they are resource requirements.

It appears that "quality," to the French, means addressing and accounting for all needs and expectations of the state and the public in their planning, design, and construction contract requirements. By means of quality assurance programs, they assure that measurable requirements of the contract and specifications are controlled and meet the specification requirements.

5.6.2 Quality Assurance Program

The government's quality assurance program includes close monitoring of contractors' execution of their quality control processes. Adequacy of equipment used, qualification of contractor personnel, and adherence to minimum sampling and testing schedules are important elements of this quality assurance monitoring process. In addition, the Government provides independent assurance sampling, testing, and inspection at the project level and bases its acceptance of the product or products on the results of this independent program.

Unless there are obvious disagreements between contractor and State test results, it is not uncommon to combine test results for statistical analysis to determine acceptability of the product. In case of wide variability between contractor and State test results, an investigation is undertaken to determine causes and resolve the issue. If the cause for the discrepancies cannot be determined, the State's test results prevail, and acceptance decisions will be made accordingly.

5.6.3 Warranties and Guarantees

Normally, on nontoll facilities, a standard 1-year warranty against defective materials and workmanship is required. On toll facilities, special warranties are applied to pavement wearing surfaces during a 3- to 5-year period. There seems to be some flexibility for establishing warranty provisions, both as to length of the warranty period and the amount and the method of providing security for the warranty. Generally, under the 1-year warranties, 5 to 10 percent of the contract amount is withheld. On toll motorways, 3 to 5 percent of the contract amount is required, up front, in the form of bank letters of credit. This security is held until the end of the specified warranty period or may be used by the Government to perform needed repairs and maintenance if the contractor fails to meet the obligations.

When proprietary materials or processes are proposed by the contractor and approved by the State, the contractor has to warrant their performance for 3 years. There does not seem to be much interest in requiring warranties on nontoll road construction, except for the standard 1-year provision cited earlier.

5.6.4 Product Evaluation

Routine performance evaluations are made on a continual basis, and records are kept that document conditions and relative performance at various stages of the life of the surface or other elements. In cases of poor performance or early failure, detailed studies are made of all factors relating to design, construction, and operational elements to determine the cause of the poor performance. It was stated that in 99 percent of such cases, the cause was determined to be nonconformance with specification requirements. When other causes are identified, necessary corrections are made on future projects.

A critical requirement for the success of France's overlay program, used on most of the bituminous-surfaced roads, is the continual evaluation of surface conditions, such as smoothness, raveling and cracking, which can be determined visually. Perhaps of more importance is their periodic evaluation of skid resistance and deflection

measurements. In this latter process, deflections indicate when it is time to structurally upgrade (overlay) the pavement before any visible signs of failure occur.

By using this overall evaluation procedure, the French believe they are able to keep their bituminous-surfaced roads in a perpetual state of high serviceability without the need for expensive rehabilitation or reconstruction work.

5.7 Summary Comments

Some things stand out as being unique or applied extensively in France in the administration of their road programs. These include the following:

- The concessionaire concept, which not only seems to result in efficient, effective high-quality facilities but involves in a cooperative way a very large representation of the country's highly trained highway, structures, and geotechnical expertise. It also provides an unusual financing system without any Government involvement, except for its stake in the equities of public/private concessionaires. Most of the required resources are obtained from bond issues on the national stock-market, or from classical medium-term loans. Complementary long-term loans are usually provided by the European Investment Bank (EIB). With the exception of the cash advances that were used at the beginning of the (motorways) system, the construction of the toll motorways in France does not receive any funds from the central government. Local communities occasionally provide some financing for specific construction projects that they are interested in. The systematic use of this special system for securing required resources, together with the extensive cross-subsidization from highly trafficked sections to less profitable ones, inside the public/private concession companies, has permitted France to realize a major construction program that has resulted in a very high-quality highway system, in only 30 years. In general, improvements and high quality are limited, in large measure, by the financial resources available to commit to the targeted objectives. The French have determined that the concessionaire concept is a proven method of generating the resources needed to accomplish their transportation goals. At the same time, they recognize this is a more costly, long-term financing mechanism than a pay-as-you-go method.

- The French aggressively encourage innovation, research, and experimental applications of new concepts, materials, designs, and construction techniques throughout a broad-based, cooperative environment that includes private, academic, and government sectors. In France, the major contractors have their own research and development (R&D) operations and develop new materials and methods. These are then introduced to the highway community, for the most part, through alternate bids. In some cases additional warranties may be required to cover additional risk.

- The French pavement-design policies, as in all countries visited, demonstrate a recognition of the need for a high-quality foundation on which to build the pavement structure. For bituminous pavements, strategies regarding stage construction requiring lower initial investments or initial construction to full design standards requiring heavy front-end investments are both considered. France favors the first strategy on the bituminous pavements construction program.

- A key to France's success appears to be the high reliance on preventive maintenance programs. For the most part, second-stage or maintenance overlays are placed before visible signs of structural distress appear. This procedure obviates the need for more costly, crisis-type repairs and maintains the surface in a perpetually high level of serviceability.

- Finally, there appears to be a genuine desire throughout the industry to produce high-quality work. In addition, contractors indicate that, if they fail to maintain high-quality standards or fail to meet technical and administrative requirements as specified, they will be excluded from further participation in the public road construction program.

6. COUNTRY SUMMARY—AUSTRIA

6.1 General Background and Organizational Structure

Austria is a federal republic consisting of nine provinces. It has a total population of 7.6 million and an area of 84,000 km² (32,400 mi²) or approximately 90 persons per km² (235 per mi²). Politically, it consists of the federation, provinces, and municipalities. The Federal constitution divides legislative and administrative responsibilities among the provinces and local governments, with some programs left to independent control by the municipalities. The Federal constitution confers responsibility of major importance to through-traffic to the Federal Government. Construction and maintenance of secondary roads are responsibilities of the provinces and local governments. The Federal Ministry of Economic Affairs is the supreme authority for Federal roads and is responsible for coordinating road engineering work and for the decision making processes related to roads.

The Division of Federal Roads is one of ten divisions in the Economic Affairs Ministry, and, under its Head of Division are 14 departments, depicted on the organizational chart in Chart 1 on the following page.

The Federation discharges its responsibilities for construction and maintenance of Federal roads in cooperation with the provincial administrative bodies responsible for provincial road engineering. In addition, special road engineering companies, similar to France's concessionaires, have been designated by the ministry to take over construction and maintenance of some Federal roads. This procedure is applied in cases involving especially expensive and difficult engineering or for roads that require separate financing and administration for their rapid planning, construction, and completion.

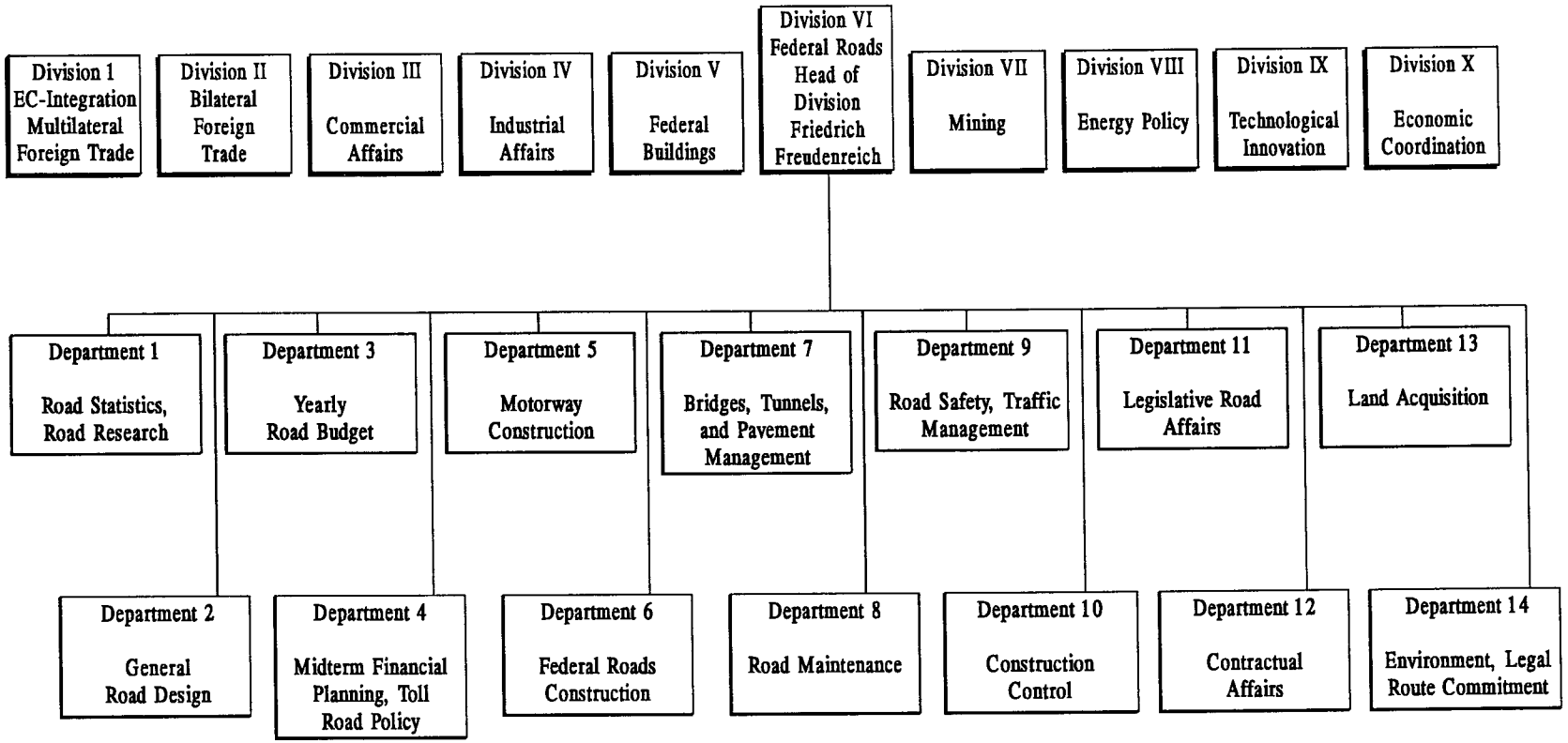
Appendix 10.1 contains several photographs concerning Austrian construction projects. Figure 16 illustrates a unique inside-lane pavement drain system. Figures 17(a) and 17(b) show a recently constructed modern Austrian rest area and a model of a flora/fauna overpass to be constructed to enhance environmental aspects of a construction project. Figure 18 shows the CATQEST team about to leave Vienna for a highway inspection trip.

6.2 Highway Program and Investment Levels

There are approximately 200,000 km (124,000 mi) of roads in Austria, including agricultural and forest roads. Of this total, 11,700 km (7,250 mi) are Federal roads, which provide the major part of interregional service and carry over 50 percent of the traffic. In 1990, the Federal Road Administration had a budget of 19.5 billion S (schillings) (US$2.145 billion). Approximately 15 billion S (US$1.65 billion) originated from normal financing (disbursed from the national general budget), and 4.5 billion S (US$0.495 billion) were provided by special financing in the form of loans for construction activities by the special road engineering companies.

Chart 1

FEDERAL MINISTRY FOR ECONOMIC AFFAIRS
Federal Minister Wolfgang Schussel



The 1993 budget for Federal Roads Administration is approximately 19.8 billion S (US$2.18 billion). Approximately one half of this budget is for construction and maintenance, over 25 percent is for interest and redemption payments, and the remaining 25 percent (approximately) is distributed among research, environmental protection, traffic safety, and natural catastrophe needs.

The breakdown of expenditures from 1990 to the present time indicates that sums spent on maintenance and debt service exceed the sums expended on new construction and extension work. The recent shift toward maintenance and refinancing is expected to continue at an increased pace, which indicates increased financing will be required to meet capital improvement needs on the Federal road systems.

The Austrians are looking for ways to obtain additional funds. Two possibilities mentioned were the conversion of free roads to toll roads and increased motor fuel taxes to be dedicated to Federal roads.

6.3 Project Development and Design

6.3.1 Life-cycle Costing

Life-cycle costing, as we define the term in the United States, is not formally used in the planning and design stages of projects in Austria. However, contractors make such analyses to substantiate and support the efficacy of their alternative proposals. Planned design lives in Austria are 50 years for bridges and hydraulic structures, 30 years for rigid or concrete pavements, and 20 years for bituminous pavements. In the case of bituminous pavements, Austria plans for overlays every 8 to 10 years, and long-term budget projections include costs for these overlays. Overlay schedules are strictly observed and rarely delayed or deferred. Reduction in maintenance costs by investing more heavily in the initial construction of pavements is stressed.

6.3.2 Project Development Constraints

Austria's two traditional principles of road planning are (1) to satisfy traffic requirements with optimum observation of operational functions and (2) the economical use of available funds. A third objective of primary importance has been added because of changing public attitudes. This new objective concerns environmental protection and harmonization of roadway design and construction with existing ecological factors. This is considered a major but essential constraint on new and reconstructed roadways. The construction of "green" bridges or overpasses for both animal and plant life in rural areas, at a cost of approximately US$1 million each, illustrates the commitment to these issues. Procedures and requirements to address these issues involve environmental impact statements, public involvement, a public review and comment period, and the study of all feasible alternative locations and design features.

6.3.3 Design Parameters

Geometric parameters are generally those that are determined best suited to accommodate requirement profiles for speed, safety, economy, and ecological concerns as well as engineering principles. Accordingly, these parameters may vary

from project to project depending on traffic volume, proximity to urban areas, number of intersections, and lateral impediments. Austria uses standardized (prescriptive) pavement design sections based primarily on sub-base soil type and volume of truck traffic. The current axle load limits are 10 metric tons (mt) (11 US tons) per single axle and 16 mt (17.6 US tons) per tandem axle. As with other EU members, these limits will probably be raised to 11.5 mt (12.7 US tons) and 19 mt (20.9 US tons), respectively, and gross vehicle weight limits will be 38 mt (41.8 US tons) to comply with standards under the EU agreements. It should be noted that Austria has applied for admission to the EU but is not yet a member. It is anticipated that the standardized pavement design sections will be adjusted to accommodate these heavier EU-standard loads by the time Austria becomes a member.

6.3.4 Use of Design Consultants

Consultants are used extensively in planning, design, and contractors' quality control and in the Government's quality assurance programs. Consultants are normally selected on the basis of technical qualifications. Compensation is determined in accordance with standard fee schedules for basic services. In cases of more complex or specialized services, fees are negotiated.

6.3.5 Construction Contractor Involvement

On some selected complicated projects, a contractor may be employed to perform constructability reviews. This is never done on simple projects. Contractors can also be involved in design through the alternative bid or side-offer procedure.

6.3.6 Design Quality Control

The Government reviews planning and design documents on all routine projects. On controversial or more complex projects that are designed by consultants, a second consultant firm is often retained to perform a peer review of the primary consultant's alternatives, evaluation processes, and resulting designs. The peer review is quite detailed, comprehensive, and thorough. Consultant liability provisions are required and are shared by both consultant firms in these cases.

6.4 Contract Award Procedures

6.4.1 Bidding/Award Types

1. Open competitive bidding. Essentially, all bidding is based on the open competitive bidding process. This has been the tradition for many years, but it has only recently been mandated by law, partly as a result of standardized requirements contained in the EU agreements. The terms "open" and "competitive" are literally applied. Conditions are the same for all bidders, and consequences can be severe if favoritism in awarding contracts can be proved.

   Awards are almost always (99 percent of the time) made to the low bidder. However, provisions exist that require pre-award evaluations to be made to determine the contractor's reliability, financial soundness, and past levels of performance before an award is finalized.

2. Other contract award procedures. The Ministry encourages the submittal of alternate proposals or side offers together with the contractor tenders. If the alternate is acceptable to the Ministry, the contractor's total bid will then reflect the cost savings of the alternate in comparison to the other tenders.

6.4.2 Road User Cost and Time Consideration

This concept is not normally used in the analysis of bids.

6.4.3 Prequalification of Contractors

All contractors on public works projects of any kind are required to have business licenses. In order to obtain a business license, the contractor must meet certain educational, experience, and financial requirements. The possession of a business license is the only prequalification requirement used in Austria to restrict bidders.

Other qualifying criteria and processes are examined and carried out after tenders are received, in order to determine the best offer. Award is made on the best offer as determined above.

6.4.4 Subcontracting Procedures

Joint ventures are encouraged and are quite common. The use of joint ventures in large measure obviates the need for subcontractors in many cases, since each of the participants in the joint venture is a partner and not a subcontractor.

6.5 Construction Quality Control

6.5.1 Specifications

The government, with industry input and cooperation, has developed a comprehensive, eight-volume set of specifications that detail all design and construction quality requirements. The specifications prescribe the material to be used, the tests to be performed, the sampling times and locations, and the test results acceptability limits.

Three basic categories of tests are required, by the contract-administration procedures. These are:

1. Suitability tests, which are performed on materials in advance of construction. These tests are the responsibility of the contractors.

2. Control tests, which are also the responsibility of the contractors and which are performed on materials during production and incorporation into the project work.

3. Acceptance tests, which are made by the Government or other owner on completed work elements and are the basis for making acceptance/rejection decisions.

Specifications, including sampling and testing requirements and rejection/acceptance criteria, are jointly developed by the contractors' association, Federal Government, provincial governments, academic communities, materials producers, and other specialists as considered appropriate by the Government.

6.5.2 Contractor Quality Control

The contractor is responsible for quality control during construction and for meeting end results for parameters such as pavement smoothness and thickness. As stated previously, the contractor must follow prescriptive contractual requirements in performing suitability and control tests. Contractors may use their own personnel to perform the required sampling and testing or may use Government-certified consultants or commercial laboratory organizations to perform such tests. The Government may use contractor quality control test results in making its acceptance decisions, provided that the sampling and testing was witnessed by the Government and that test results are comparable to the Government's acceptance test results.

6.5.3 Work Force Training and Certification

Technician-type training for sampling and testing is a responsibility shared by contractors and the Government. Certification is not required for contractor or Government personnel to perform required sampling and testing, but they must exhibit the necessary knowledge and skills to perform such tests accurately. Consultant personnel used by either the contractor or the government must be formally certified as qualified to perform the assigned tasks. Similar training is provided for the inspection and construction work force.

6.5.4 Incentives and Price Adjustments

Incentives are not provided for quality exceeding that specified. Disincentives, in the form of price reductions for deviations from contract specifications, are used. The amount of reduction is determined by formulae based on statistical analyses of test results. In cases of more serious deviation from specification requirements, the deficient work is removed and replaced. Ingenuity expressed in alternate bid offers that are accepted by the Government could be considered an incentive because the alternate offer typically results in more profit to the contractor.

6.5.5 Legal Issues

Legal issues do not appear to be a major concern in Austria, either in award procedures or construction contractual matters. This is attributed to Austria's bidding system and requirements, the trust contractors have in the Government, and clear and prescriptive requirements in the long-standing Government regulations.

6.6 Quality Assessment and Performance Evaluation

6.6.1 Definition and Measurement of Quality

Quality is generally defined in terms related to the total project: aesthetics, environment, low noise levels, convenience of use, etc. Accordingly, the Austrians say that quality is defined or described in the project design and specifications. These are both formulated to meet the needs and desires of the public. To ensure quality, it is then necessary to adhere rigidly to and enforce the specification requirements. The final measure of quality is determined by public acceptance.

6.6.2 Quality Assurance Program

The Government is responsible for project quality assurance, and, accordingly, it provides continuous project inspection and performs tests for acceptance purposes. In addition, it continually monitors the contractors' quality control activities and witnesses sampling and testing performed by the contractor.

6.6.3 Warranties and Guarantees

Normally, contractors are required to warrant their work for up to 5 years and to provide a bank security of 3 percent of the contract cost to back up the warranty. In almost all cases, the work proves satisfactory, and the contractor's security is released at the end of the warranty period.

6.6.4 Product Evaluation

Initially, the product is evaluated on the basis of contract compliance and visual inspection. Criteria are currently being developed for a systematic procedure for periodically measuring road noise levels, skid resistance, rutting, and probably deflections. This will provide important performance evaluation information, as well as data on which to base pavement overlay or reconstruction decisions.

6.7 Summary Comments

Few things related to pavement durability and long-term, high-quality serviceability are unique to Austria, as noted below:

- Contracting and contract administration requirements are very similar to those used in the United States, except for the use of warranties of 2 to 5 years on all contractor work. Austrians also rely heavily on roadway companies (concessionaires) for design, construction, operation, and financing of major projects.

- Preventive maintenance appears to be a high priority with the Austrians. One of our hosts stated that they "would not permit cracking or potholes to ever develop." The implication was that these common problems are prevented by early and effective maintenance measures.

- Partly because of increased demands by the public, much greater investment is required now for environmental and ecological issues and for other public comfort amenities, such as plush rest-stop areas.

- Increased investment levels will be required to accommodate new demands and yet maintain current standards for other elements, such as pavement structure.

7. COUNTRY SUMMARY—SPAIN

7.1 General Background and Organizational Structure

Spain is a nation of 39,000,000 people living in a country 504,800 km² (194,918 mi²) in area. Population density is thus 77 people per km² (200 per mi²). Spain has a democratic national government, and the nation is politically divided into 17 provinces, autonomous communities, similar to the States in the United States. This substructure is somewhat complicated in that there are also territorial regions that approximately duplicate the autonomous community boundaries and that have political and administrative organizational structures. In addition, two of these territorial regions are more independent than the others. They directly impose taxes and build and maintain their own highways. The central Government, therefore, has no jurisdiction over highways in these two regions.

There are a total of approximately 318,000 km (197,600 mi) of roads in Spain. Of this total, the central government controls 20,500 km (12,700 mi) and the autonomous communities control 75,000 km (46,500 mi). The central Government retains the authority and responsibility for approving designs, plans, and construction on the 20,500 km under their control, but relies heavily on the autonomous communities to perform many administrative and technical functions in the management of the 20,500 km network. In addition, private toll authorities generally design, construct, operate, and maintain toll facilities on the 20,500 km Federal Government network. These facilities revert to the Government after a prescribed interval, usually 30 to 50 years. The 20,500 km of roads under direct jurisdiction of the central Government carry 60 to 65 percent of the total highway traffic.

The Secretary General for Infrastructure and Transport is one of six secretariats under the Minister of Transport. The Secretary General's office is further organized into departments for roads, toll highways, and railways. Management of the Federal highway program is carried out under the general authority of the Federal Government by 15 regional offices. Two additional regional offices are completely autonomous, as indicated previously. The regional office jurisdictions are established on the basis of area and highway program size and do not necessarily coincide with the autonomous community boundaries. Each of the regions is functionally organized with elements for projects and works, maintenance, and administration.

Except for routine, day-to-day maintenance activities by the regions' own staffs, maintenance work is generally contracted out to private firms on the basis of competitive bids and known capability of the bidders. Individual maintenance contracts are limited by law to 4 years' duration.

Appendix 10.1 contains several photographs of Spanish construction projects. Figure 19 shows a bridge overpass structure that is part of the outer ring road near Madrid. Figures 20 and 21 show precast bridge walls with bolted-on panels and asphalt paving, respectively. Figure 23 illustrates the first high

occupancy vehicle (HOV) facility constructed in Spain.

7.2 Highway Program and Investment Levels

Budgets or investments for road programs are not fixed by law or formula, but are determined annually by the highest levels of government. These determinations are based not only on total transport infrastructure needs, but also on other high-priority needs of the country. Accordingly, road planners face funding uncertainties from year to year because motor fuel taxes, toll collections, and other related taxes are not dedicated to transport programs, but go into the general fund for general allocations.

The current level of investment for roads is approximately 400,000 million pesetas (US$3 billion) per year, with 250,000 million pesetas (US$1.875 billion) earmarked for plan execution (construction), 100,000 million pesetas (US$750 million) for safety, and 50,000 million pesetas (US$375 million) for maintenance.

7.3 Project Development and Design

7.3.1 Life-cycle Costing

Life-cycle costing is not utilized; however, benefit/cost analyses are used extensively in the planning process. Basic assumptions for all analyses include a 30-year useful life and 15 percent residual value. Many factors go into the analysis, such as cost of operation, fuel, safety (i.e, accidents), maintenance costs, and continuity of use. Environmental issues are also becoming a substantial factor in the analyses, adding 20 to 30 percent to the cost, but, since the benefits of these enhancements cannot be quantified in economic or monetary terms, they are generally omitted from cost/benefit calculations. It is usual for political considerations to heavily influence or override cost/benefit considerations in the decisionmaking process.

7.3.2 Project Development Constraints

A major and fairly recent development in Spain has been the implementation of policies requiring public involvement and stringent environmental mitigation criteria. Insertion of a somewhat aggressive public-involvement step between design and construction stages has significantly lengthened the project-development stage. Also, due to the increased investment levels (20 to 30 percent increase) required to accommodate the aesthetic and environmental-protection measures demanded by the public, project construction has been significantly delayed.

7.3.3 Design Parameters

In Spain the pavement design and road-bed design philosophy is to invest heavily in the initial construction, starting with construction of high-quality, stable pavement-structure foundations. Design life for motorways and freeways is 20 years for the road bed and asphalt pavement, 30 years for concrete pavement, and 50–100 years for large structures. Hydraulic design is normally 30 years for culverts and 100–500 year floods for larger structures.

The legal maximum gross truck weight is 43 metric tons (mt) (47.3 US tons), a limit being reduced to 38 mt (41.8 US tons)

to meet the EU standards. The reduction is being phased in over a 10-year period to allow for the maximum useful life of existing, larger-capacity trucks. The Spanish indicate that even now load limits are not generally observed, and there is little actual governmental enforcement of the statutory weight limits. The perception is that this situation is fairly common in the EU and is a situation that could cause problems unless uniform enforcement policies are implemented. In the meantime, Spain will continue to base pavement and structures designs on the existing limits of 13 mt (14.3 US tons) for single axles, 21 mt (23.1 US tons) for tandem axles, 27 mt (29.7 US tons) for triple axles and 43 mt (47.3 US tons) gross weight. Standard pavement designs are developed by the Ministry and issued in design catalogues for use by Ministry and consultant designers.

There is not a mandatory recycling program in Spain, but some effort is being made to re-use discarded rubber tires for other than highway purposes. Mine waste and worn out asphalt pavement materials are used for roadbed and base materials. Some fly ash is used for base stabilization.

7.3.4 Use of Design Consultants

Consultants are used almost exclusively by the Ministry and the autonomous communities for project development, testing, and contract administration. The Ministry engineering staff is generally limited to oversight and review of the consultants' work, interpreting requirements, scheduling and interagency coordination functions. Consultant services are procured through open bidding procedures where the bidders describe their qualifications and quote a price for performing the prescribed services. The bids are evaluated, and a short list of the best three or four offers is developed. From this short list, a selection for award is made.

Consultant liability is clearly defined during both design and subsequent construction. During design, the consultants are responsible for correcting all such problems as defects, technical shortcomings, errors concerning materials, or omissions that are brought to their attention, within a maximum time period of 2 months. If these shortcomings are not corrected within this time period, the Administration has the option of resolving the contract while seizing the bond and requiring the consultant to pay a compensation fee of 25 percent of the agreed price, or granting a one-month (and only one-month) extension to correct the defects. In this second case, the consultant would have to pay a fine equivalent to 25 percent of the contract price. If this second deadline were not met, the contract would be dissolved, the bond seized, and the consultant required to make a compensation payment equal to the contract price. There are apparently few, if any, cases in which deficiencies are not corrected within a reasonable length of time; accordingly, penalties are rarely applied.

In cases in which there is more than a 20 percent increase in the construction budget stipulated in the project, whether it is due to waste or defects due to errors or omissions charged to the consultant, the Administration *can* set up a system of penalties that would decrease the amount agreed upon in the contract. Based on the

percentage of the budget increase, the penalty could reach a maximum amount of 50 percent of the consultant contract price. Again, these measures have rarely been applied.

In addition, the consultant must answer to the Government and to third parties for all damages suffered during the construction and use that are the result of project defects or technical shortcomings, the use of faulty materials, omissions, and infractions of laws or regulations for which the consultant is responsible. The consultant may be held responsible for 50 or even 100 percent of the damage claims, up to a maximum amount of five times the contract price. This sum must be paid within a period of 10 years from the date of the project's completion. The unpaid portion of the compensation to third parties is the responsibility of the Government.

7.3.5 Construction Contractor Involvement

Constructability reviews are not normally conducted but can be performed by a second consulting firm, if ordered by the Ministry. The design/build concept is not widely used in Spain, but when it is used, the construction contractor is responsible for all design as well as construction. At times, this is done by a single company that has total engineering/construction capability. At other times, construction contractors and consultant engineering firms will organize joint ventures to design/build projects.

7.3.6 Design Quality Control

The ministry has no established guidelines for design quality control, but they do review project submittal and environmental impact statements for errors and to assure the designs comply with the Ministry's guidelines and administration laws. Proprietary items cannot be specified without "or equal" provisions. This feature is generally reviewed by the Ministry to ensure compliance with regulations.

7.4 Contract Award Procedures

7.4.1 Bidding/Award Types

Spain uses three basic contract award procedures.

1. Public auction. The auction process can be either open or restricted and is generally used on simple projects. The lowest bidder is normally awarded the contract, as long as the bid documents do not indicate "recklessness," understood to mean extremely low prices.

2. Detailed project analysis. This procedure is used on larger projects when the Government believes it is not possible to establish a complete design and budget for the work. In addition, technical solutions and further designs must be proposed by the contractors to address the complexities and to provide for contingencies that may arise during construction. Under this system, only selected contractors may submit bids, and the Government must specify the criteria that will be used in evaluating proposals. By a careful evaluation process, the three best proposals are selected and sent to the General Secretary for Transportation Infrastructure, who makes the final award determination.

3. Direct award. This system may be used for very small, lighting and pavement-patching projects or on highly complex and costly projects. These might be projects that are in a high-urgency category, projects that have been studied by competent authorities who have determined the work is of such an artistic and unique nature that only highly specialized contractors could perform it in an acceptable manner, or projects that must be secret for reasons of national security. Under the direct-awarding procedure, the administration requires proposals from at least three contractors. The contract is usually awarded to the lowest bidder.

The Spanish award procedures appear to be somewhat complicated. However, they are clearly defined in the regulations and are well known to the industry.

7.4.2 Road User Cost and Time Considerations

No general binding criteria are used to evaluate road user costs and time considerations in contract award procedures. These factors are given some weight in the planning and design stages and may receive indirect consideration in the bid evaluation processes. However, these considerations usually do not overcome the low bid in contract award decisions.

7.4.3 Prequalification of Contractors

All contractors must be registered, classified, and licensed to bid. Screening and evaluation procedures and issuance of necessary registration and licensing documents are performed by the Ministry of Economics, independent of the Transportation Ministry. Registration defines the size limits that the contractors can bid on, based on the technical capability of the personnel, equipment owned, financial solvency, and experience in the various types of work to be performed. However, the Transportation Ministry has ultimate authority to select the contractors for project awards.

A new addition to the Spanish registration process is the certification of contractors' internal quality control systems. This process is very similar to the ISO 9000 certification process. The new process is called the Asociación Español de la Normalización (AENOR) and is administered by the Ministry of Commerce for all Spanish companies. No companies are certified to date, but several are in the process. It is anticipated that companies will take approximately six months to get their quality policies in place. Considerable internal training will be required before any company will be able to attain certification. This type of certification will be included as a prior requirement for contracting.

7.4.4 Subcontracting Procedures

Contractors are permitted to subcontract up to 50 percent of the project cost, and it is not unusual to do so. On State projects, the contractor is responsible for assuring that subcontractors have quality assurance programs meeting State criteria. The State deals directly with the prime contractor, not subcontractors, on all project administration matters.

7.5 Construction Quality Control

7.5.1 Specifications

Specifications used in Spain can best be described as a combination of methods and end results. Such things as asphalt mix and concrete mix ingredients are prescribed in the specifications. The end-result product must then meet specified requirements for such things as strength and smoothness.

An exception to the method or prescriptive approach is one in which "secret ingredients" or proprietary products are permitted in some project asphalt mixes. In these circumstances the end-result parameters govern, and the risk is with the contractor. It should be noted that the Spanish encourage use of new and experimental materials and designs in bituminous mixes and even require their use in some projects. Under these conditions, the State accepts the risks, rather than holding the contractor responsible if the experiment fails.

Measurable properties of materials such as aggregate gradations, asphalt cement content and density of asphalt pavement are tested on a random-selection basis and evaluated by statistics to determine degree or level of acceptability. The procedure appears to be very similar to procedures used in the United States.

7.5.2 Contractor Quality Control

Contractors are now being held more responsible for their own quality control, both internally and for contract delivery. However, quality is universally recognized as being critical and is highly stressed. It is also recognized that contractors and the Government both have responsibilities to assure that quality is attained. Most contractors and Governmental entities believe it is important to establish an industry/government relationship that is cooperative rather than adversarial, while recognizing that they each have separate responsibilities. The Government has developed different levels of quality control responsibilities, depending on the type of work, to assign risk commensurate with the road use. Contractor quality control is discussed further in Section 2.3 above.

7.5.3 Work Force Training and Certification

On State projects, the contractors are required to have a quality assurance engineer responsible for quality assurance on the projects. This individual must have an engineering degree and a minimum of 5 years' experience. The required qualifications of technicians and other work force members on the contractors' staff are not dictated by the State. This issue falls within the realm of the contractors' responsibility.

Spanish officials generally believe they will be adequately protected by the warranty provisions and contractor quality assurance plans to assure good quality. They also believe the warranty provisions and additional penalty provisions provide the contractors ample incentive to use only qualified and competent personnel to perform assigned tasks.

7.5.4 Incentives and Price Adjustments

Bonuses are not paid for products that exceed specified requirements. Price reductions may be used based on statistical formulas, but more often penalties are in the form of removal and replacement of defective work at the contractor's expense, loss of the warranty bond, added monetary penalties, plus contract cancellation in some cases. Incentives may be sparingly used for early completion or innovative, alternative proposals when accepted by and resulting in savings to the State.

7.5.5 Legal Issues, Claims, Partnering

The Spanish philosophy is to resolve issues at the project level, when possible. The Spanish objectively study controversial matters relating to warranty applications in cases where causes of early failures or poor performance are not readily ascertainable; that is, in cases in which there is no doubt as to whether the problem is due to faulty design or specifications, or due to noncompliance with specifications and poor workmanship on the part of the contractor.

The Government does not consider the modifications of contracts to be a major issue. There has been an average of one contract modification for every three projects during the last 4 years. The Government staff appears to be objective, and possibly liberal, on most issues involving modifications. The use of change orders, while infrequent, normally accommodates contractors' concerns.

When disagreements cannot be resolved through these means, they normally go to a binding arbitration process to settle the issues. Only infrequently are controversies adjudicated through the legal system.

7.6 Quality Assessment and Performance Evaluation

7.6.1 Definition and Measurement of Quality

The Spanish broadly define "quality" as something that satisfies customers' needs and expectations. To assure that these expectations are understood, the roads administration uses a bottom-up approach by advertising for public input in the planning, preliminary, and final design stages of project development. In this regard, the public is becoming more discerning and is demanding higher standards for safety-related issues and for environmental protection. While they also expect roads to be smooth and durable, the public is generally willing to accept governmental authorities' technical decisions and specifications relating to these features.

Up to this point, the Spanish definition of quality is essentially "doing the right things." The second part of the definition would then be "doing the things right," or complying with all design, specification, and legislative requirements.

7.6.2 Quality Assurance Program

There is no single policy or set of requirements for quality assurance applying to roads on a countrywide basis. This is so because each of the autonomous regions or communities has the responsibility and

authority to establish policies and procedures for administering construction projects.

On work controlled and administered by the Federal Government, very rigid requirements are placed on the contractor for quality assurance. All bidders on a project are required to include a quality assurance plan in their bid submissions. The plan must include minimum project level sampling and testing schedules to be performed by project personnel. The contractor is also required to have an independent organization responsible for providing independent sampling, testing, and general oversight of project-level quality control activities. State law requires contractors to spend up to one percent of project costs on the quality assurance program.

The Government, in many cases, will base its product acceptance decisions on the contractors' general quality control measures and test results, with little independent government testing. However, it will have a qualified technician or inspector on the project at all times to monitor and witness the contractors' quality control activities.

The aforementioned government policies and procedures are quite different from those of the autonomous region of Madrid. Madrid depends almost entirely on a strong internal quality assurance program and places high emphasis on the training of their personnel, who perform quality assurance tasks. The Madrid region encourages contractors to produce high-quality products, but requires no specific quality assurance plan. The contractors can use whatever measures they believe necessary to assure quality, and the region will base all acceptance decisions on inspections and tests performed by their own personnel.

7.6.3 Warranties and Guarantees

The law requires that all work be warranted for 1 or 2 years, depending on the type of work involved. Progress payments are not withheld to secure the warranty. Rather, bond or financial security totaling 4 percent of the contract amount is required, and this is released only at the termination of the warranty period. It should be noted that the European definition of a bond is not the same as the insurance instrument as understood in the United States. The amount of warranty bond or financial security can be increased to a maximum of 20 percent of contract amount in cases where the successful bid is 10 percent below the average bid quotations or where the State believes they need additional protection, if a bid appears somewhat "reckless" or unrealistically optimistic, but not outright rejectable.

The State performs routine periodic inspections during the warranty period. The contractor is responsible for maintenance and repairs during the warranty period. This includes damage as a result of construction deficiencies as well as accidents. In the latter case the contractor can sue to recover cost from private parties who caused the damage and can require the contractor to perform maintenance and repair work during this period. There are instances in which a contractor fails to perform these functions. In these cases, the State will then perform the work with their own forces or with

another contractor. The consequences to the original contractor in such cases are loss of bond plus up to a 20-percent additional penalty and loss of opportunity to compete for future projects.

The Spanish believe they need the protection provided by warranties and have experienced situations where bonds totaling 10 percent of the contract cost have not been adequate to cover the State's costs for repair and maintenance work required during the warranty period.

7.6.4 Product Evaluation

The Spanish rely to a considerable extent on feedback from politicians and the public as a product evaluation tool. They also routinely measure such things as smoothness and skid resistance of pavements, and they analyze operational efficiency and accident frequencies, locations, and causes.

7.7 Summary Comments

- The Spanish are very receptive to practices and procedures perceived as successful in other countries.

- The economic situation is a serious concern to roads ministry officials. Despite this limitation, they are making good progress toward their overall objectives and are committed to a philosophy of "progress with quality."

- The Spanish appear to firmly believe that quality is not expensive if viewed in the long term.

- They believe a strong cooperative effort between the Government and private industry (contractors and consultant engineers) is essential to their continued progress.

8. ACKNOWLEDGMENTS

Special acknowledgment is due all the European transportation ministries, contractors, and researchers for their gracious hospitality and for sharing their experience and time with the scanning team. Our hosts, without exception, were gracious, accommodating, and generous with their time and efforts. They were also tolerant of the tour members' lack of foreign language skills and were often candid in presenting assessments of their countries' practices.

Some of the hosts who deserve special mention were: Dr. Karl Ribbeck of the German Ministry of Transportation; Dr. Karl Robl of the Central Association of the German Building Trade; Dr. Vollpracht of the Berlin Ministry for City Planning, Housing, and Traffic; Mr. Eric Boiteux, French Department of Public Works, Transport and Tourism; Mr. Phillippe P. Petit of the French Motorways System; Dr. Helmut Prager of the Austrian Ministry of Economics; Dr. Angel Lacleta-Muñoz of the Spanish Technical Highways Association; and Mr. Liberto Serret Izquierdo of the Spanish Directorate General of Highways.

Thanks are also given to the FHWA, Office of International Programs, for technical assistance and funding of this effort.

Particular acknowledgment is due the Transportation Technology Research Center (TTEC) at Loyola College in Maryland for its coordination of the team and production of this report. Finally, special thanks are given to TTEC's subcontractor, American Trade Initiatives, Inc., for arranging the meetings, planning the travel, and escorting the team.

This scanning effort would not have been possible without the invaluable contributions of everyone mentioned above.

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9.1 Cited References

AASHTO, *Report on the 1990 European Asphalt Study Tour*, American Association of State Highway and Transportation Officials, Washington, DC, 1991.

FHWA, *FHWA International Scanning Tour for Geotechnology—Soil Nailing Summary Report*, Pub. No. FHWA-PL-93-020, Federal Highway Administration, United States Department of Transportation, Washington, DC, May 28, 1993.

FHWA, *Report on the U.S. Tour of European Concrete Highways*, Pub. No. FHWA-SA-93-012, Federal Highway Administration, Washington, DC, 1993.

International Road Federation, *World Road Statistics 1987-1991*, Washington, DC, 1992.

National Technical Information Servcie, *The World Factbook 1991*, Washington, DC, 1991.

Transportation Research Board, "Innovative Contracting Practices," TRB Circular No. 386, Washington, DC, December 1991.

9.2 Selected support documentation distributed by European hosts

(Note: Citations are given to the fullest extent possible, though some are incomplete. This listing is provided to indicate the extensive range of support documentation provided by the European hosts in their strong effort to assist the CATQEST team.)

"A New Specification for Structural Design of Pavements in Austria," Litzka and Herbst, 1986.

"A Survey of the Austrian Road Network," Freudenreich, 1990.

"Design and Construction of Toll Highways in France," SCETAUROUTE.

"Federal Traffic Infrastructure Plan 1992," Federal Ministry of Transport (Germany), 1992.

"General Administrative Clauses," MOPT, Madrid.

"General Organization of French Highway Services," Raymond Sauterey, Engineer, General Public Works, 1990.

"La Caisse Nationale des Autoroutes—1963 to 1993," French government, 1993.

"Mautpflichtige Autobahn und Schnellstra Benabschnitte in Österreich," August 1993.

"Report on the First General Roads Plan," MOPT, Madrid, December 1992.

"Roads in France 1993," Ministry of Public Works, Directorate of Roads, 1993.

"Roads in the Federal Republic of Germany 1990," Walter Stoll, Director General for Road Construction, Federal Ministry of Transport, 1990.

"Roads of Austria," Austrian central government, 1990.

"Special Administrative Clauses Applicable to the Contracting of Public Works Under the Direct Contracting System," MOPT, Madrid, March 1993.

"The French Auto Route System in 1990," Association of French Motorway Companies, 1990.

"The Highway Engineering Organization (SCETAUROUTE) and Its Relations with Mix-Economy Concessionary Companies (SEMCAs)," Phillipe Petit, date unknown.

"Trans-European Network: Toward a Master Plan for the Road Network," Commission of the European Communities, Directorate General for Transport, December 1992.

"Urban Main Roads—Recommendations for Planning and Design," MOPT, Madrid, 1993.

"Value Analysis—For Road Construction Project," G. Vuillemin, June 1992.

In addition, the CATQEST team received written responses to its questions prepared by appropriate MOPT and Madrid Region officials, with translation into English extended as a courtesy. As a further courtesy, the team much appreciated being provided a transcription of Madrid meetings with all Spanish speakers' remarks translated into English.

APPENDIX 10.1: SELECTED PHOTOGRAPHS TAKEN BY CATQEST TEAM

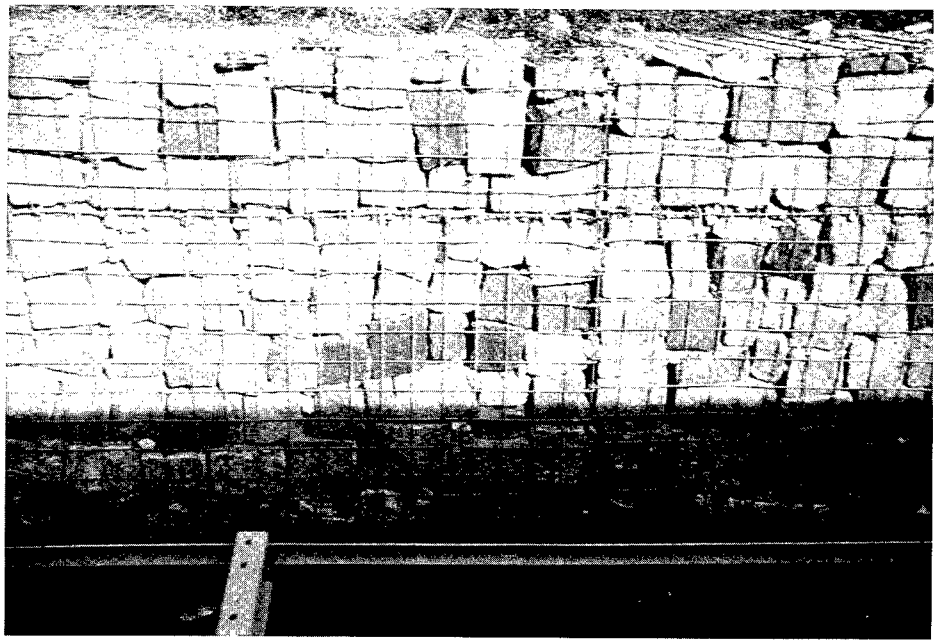


Figure 1: Environmental retaining wall on depressed highway section, Berlin.

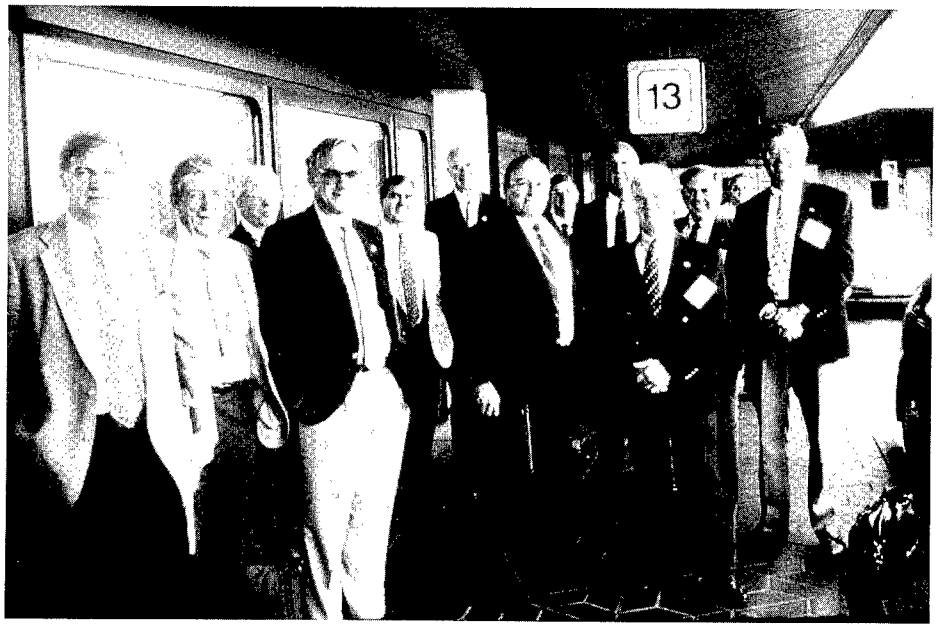


Figure 2: CATQEST team in Bad Godesburg, preparing to leave for meeting in Bonn with German transport officials.

Figure 3: Four-lane autobahn, Berlin. Note lane closure and traffic direction arrow.

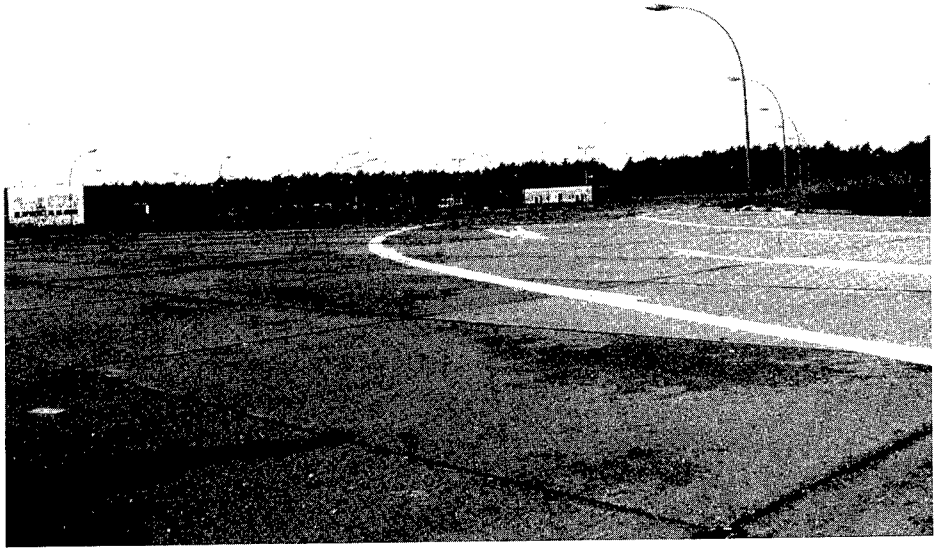


Figure 4: Old autobahn (constructed in 1926). Former checkpoint entrance to East Germany, Brandenburg.

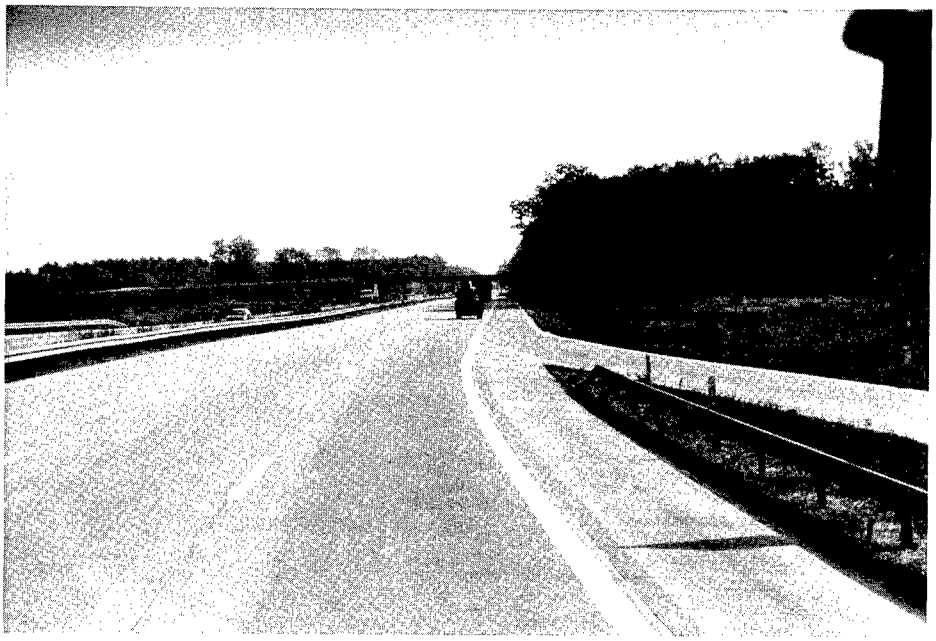


Figure 5: Six-lane autobahn—right entrance ramp, Brandenburg.

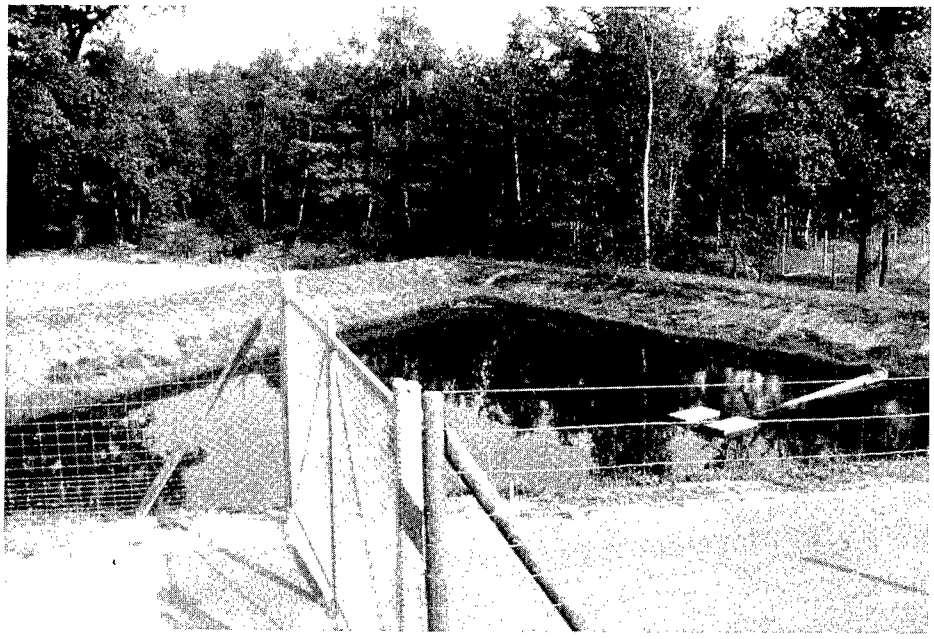


Figure 6: Experimental prototype water-collection/treatment facility adjacent to autobahn in Brandenburg.

Figure 7: Concrete paving, Brandenburg. Separator fabric is placed between frost protection base layer and surface concrete. Fabric is nailed to the base.

Figure 8: Zero-slump, bottom layer of concrete surfacing is dumped on grade ahead of lead paver.

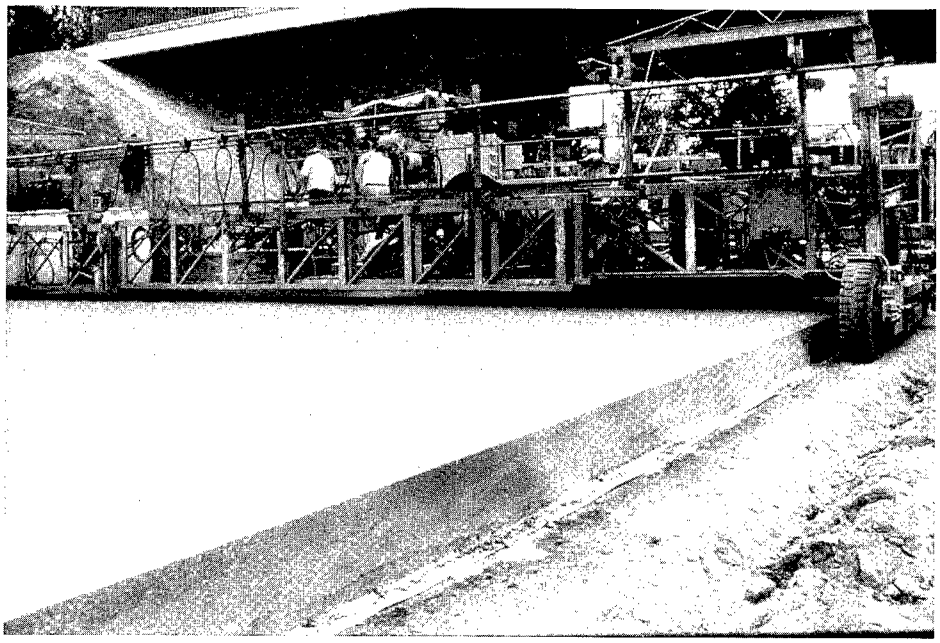


Figure 9: Fresh concrete pavement directly behind finish paver. Note zero-slump, sharp corners of slab.

Figure 10: Bridge construction on route A-15, Brandenburg.

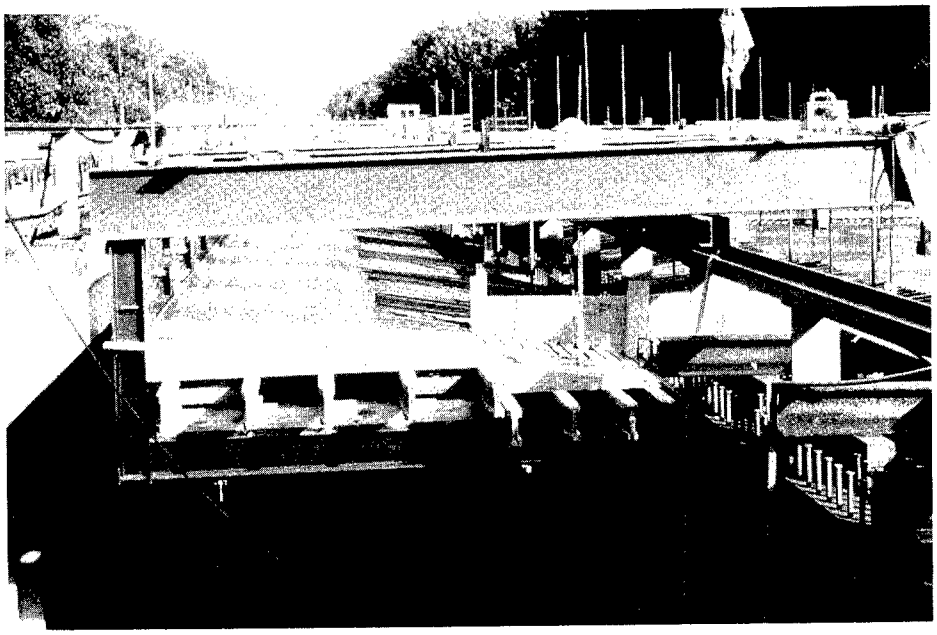
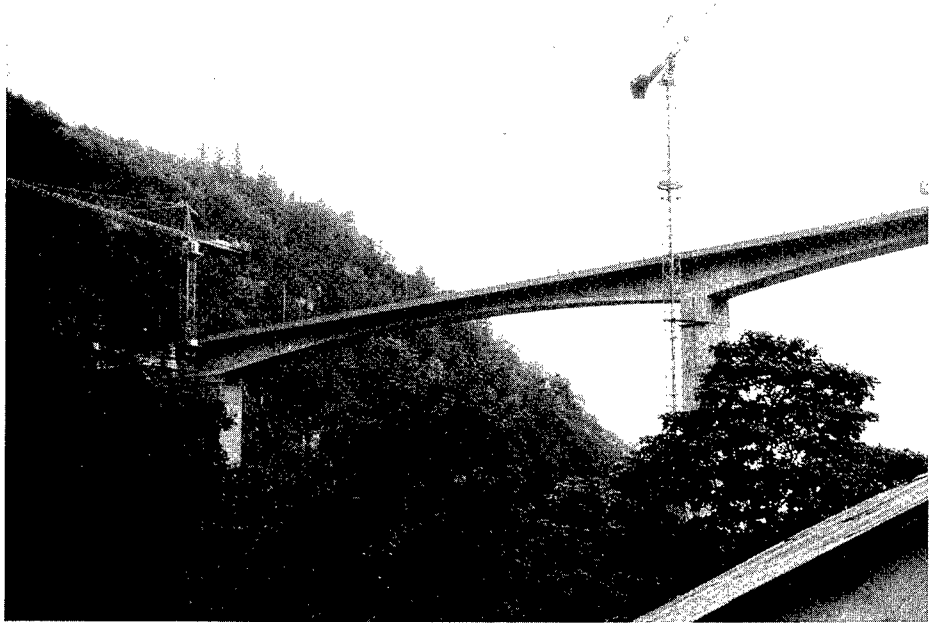
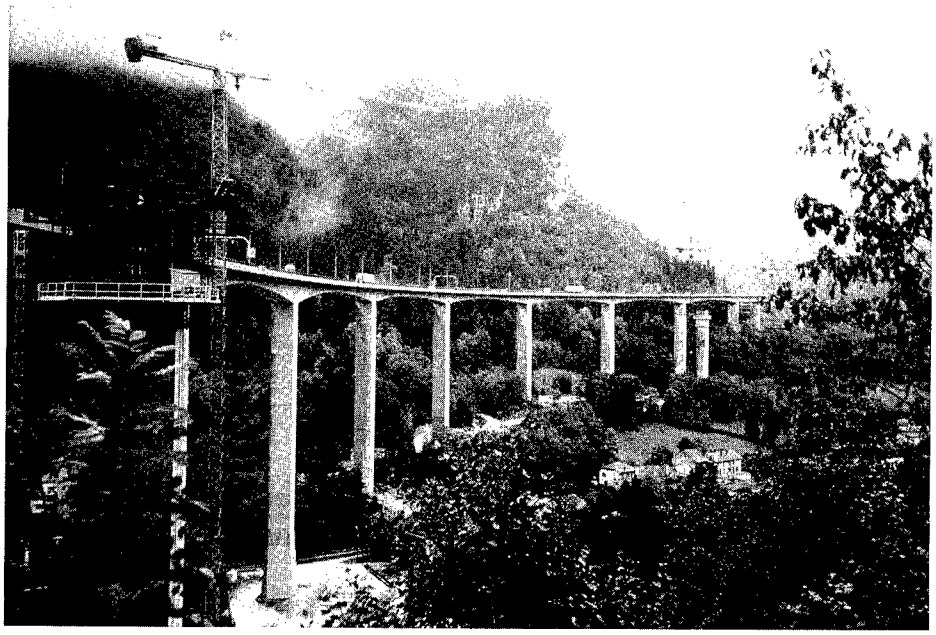


Figure 11: Bridge construction, route A-15, Brandenburg. Note cantilevered form supports —no vertical falsework.

Figure 12: Interchange construction. Inner-ring autobahn, Berlin.





Figures 13 (a) and (b): High, twin structures (second structure under construction) near Nantua, France.

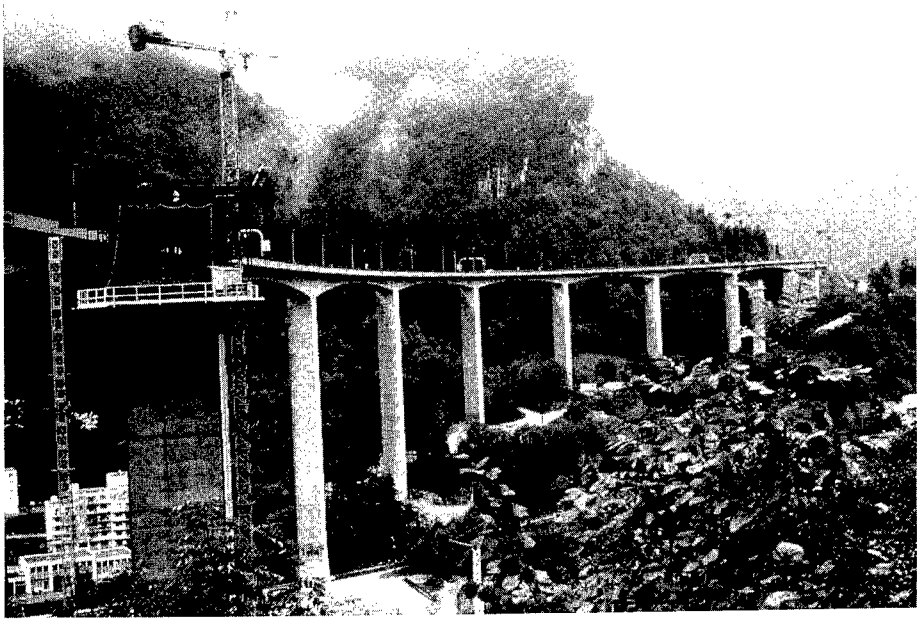


Figure 14: Another view of the high, twin structures near Nantua, France.

Figures 15 (a) and (b): Team meeting in Paris to review German and French teams' preliminary findings.

Figure 16: Unique inside lane median pavement drain under construction in Eastern Austria.

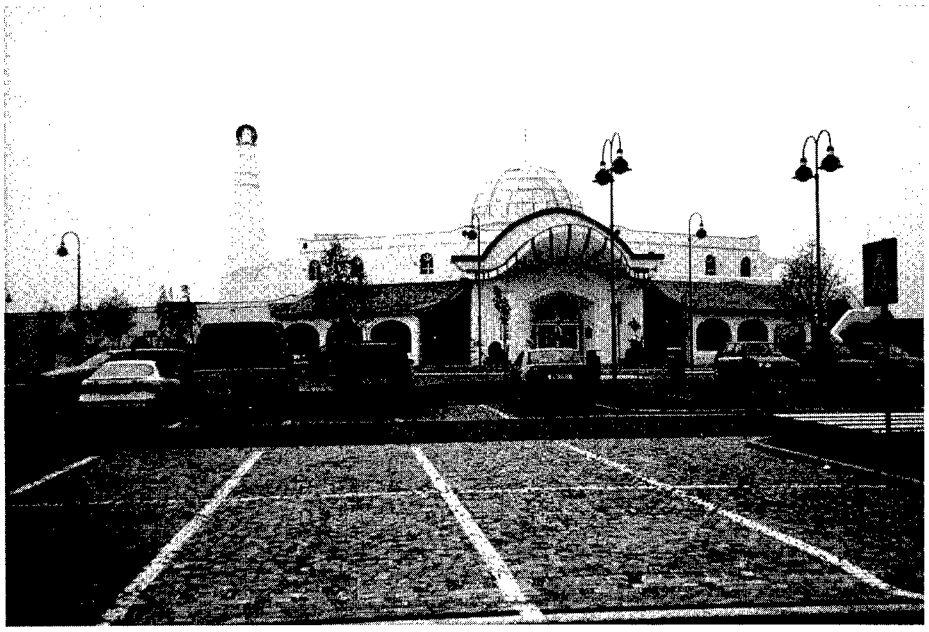


Figure 17 (a): Front view of recently constructed modern rest area, Austria.

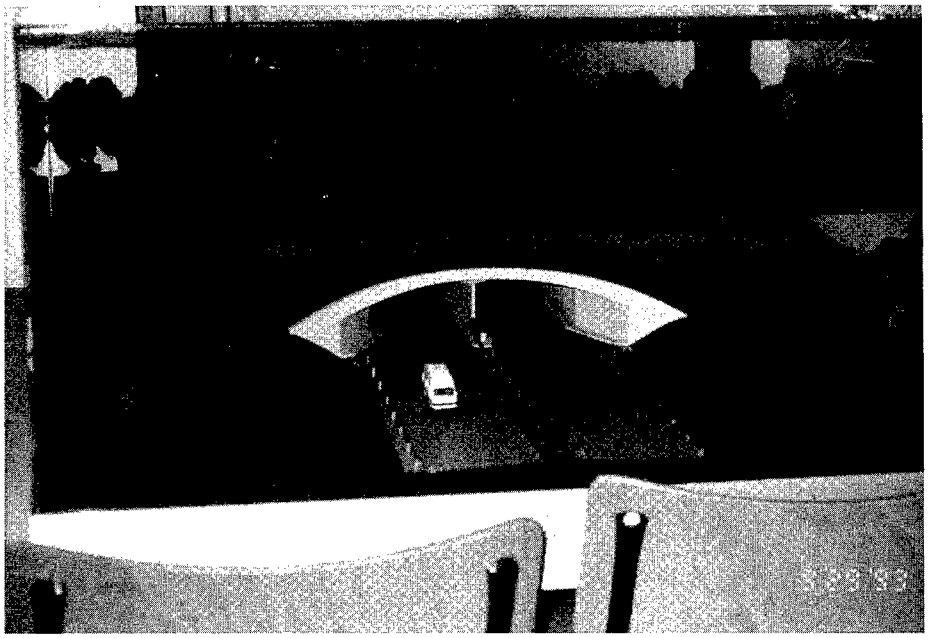


Figure 17 (b): Model of flora/fauna overpass to be constructed to enhance environmental aspects of project, Vienna.

Figure 18: CATQEST team in Vienna. Ready to depart on inspection trip.

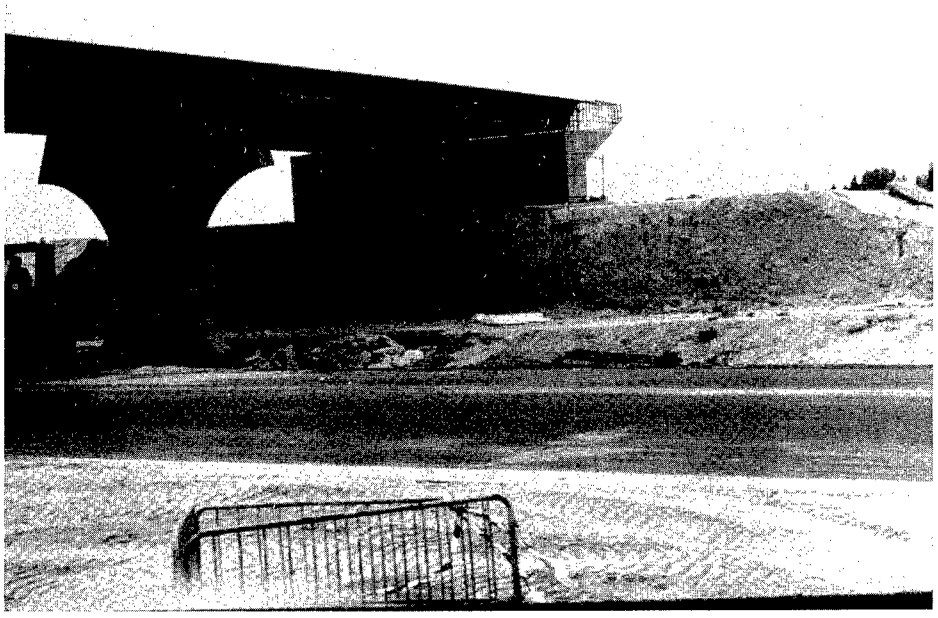


Figure 19: Bridge overpass structure—ring road construction, Madrid.

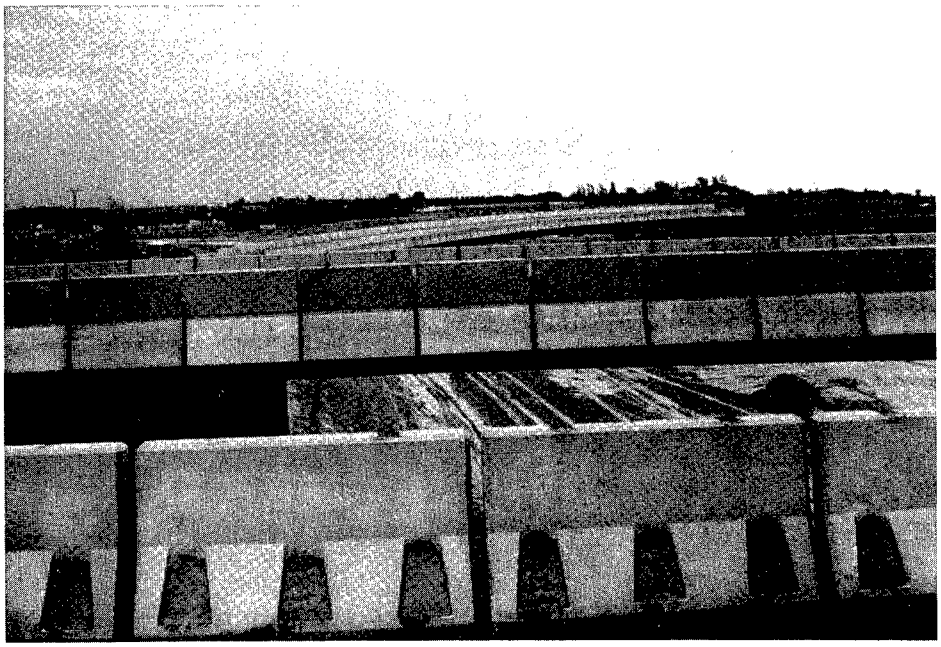


Figure 20: Precast bridge parapet walls. Bolted on panels. Madrid.

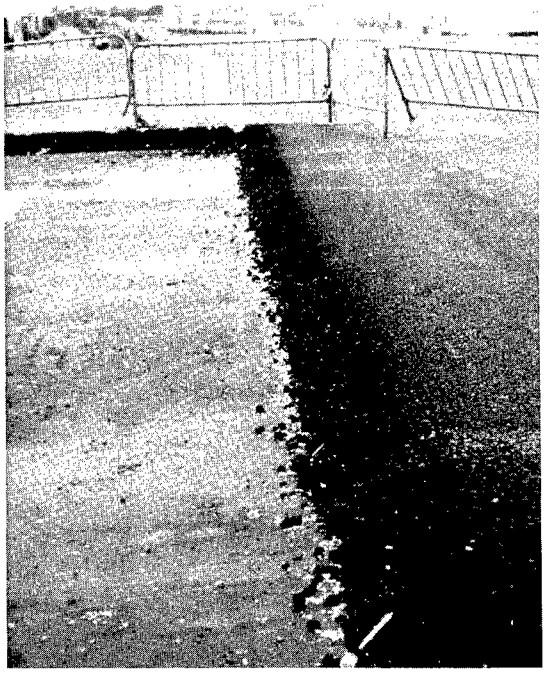


Figure 21: Asphalt paving underway, Madrid.

Figure 22: CATQEST team at Ministry of Public Works and Transport, Madrid. Left to right: Messrs. Sparlin, Testa, Kraemer, Kane, Wert, Flowers, Honeywell, Smith, Jensen, Bohman, Bower, Ulland, Wilcox, Kassoff, Geiger.

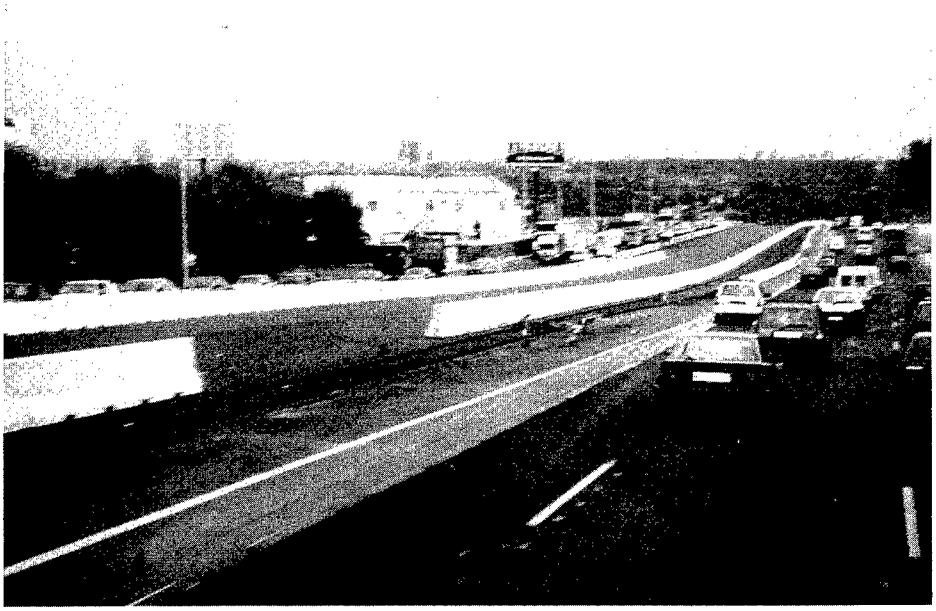


Figure 23: First high occupancy vehicle (HOV) facility constructed in Madrid, Spain.

APPENDIX 10.2: GLOSSARY

AASHTO	American Association of State Highway and Transportation Officials
ACEC	American Consulting Engineers Council
ACPA	American Concrete Pavement Association
ADR	alternative dispute resolution
AENOR	Asociación Español de la Normalización (Spanish addition to the certification of contractor's internal quality control systems, similar to the ISO 9000 certification process.)
AGC	Associated General Contractors of America
ARTBA	American Road and Transportation Builders Association
ASFA	Association des Sociétés Françaises d'Autoroutes (Association of the French Toll Highways Corporation)
CATQEST	Contract Administration Techniques for Quality Enhancement Study Tour
CONFIROUTE	A French concessionaire company
C.C.T.G.	Cahiers des Clauses Techniques Générales (General Technical Clause Books)
DBE	Disadvantaged Business Enterprise
DDE	Department des Etát French county public works directorates
DM	Deutsche mark, German currency unit (1 DM ≈ US$0.61)
DOT	Department of Transportation
EAST	European Asphalt Study Tour
EC	European Community (now European Union)
EIB	European Investment Bank
EPA	Environmental Protection Agency

EU	European Union (formerly EC)
FHWA	Federal Highway Administration
Franc	French currency unit (1 franc ≈ $0.18 US)
HOV	high-occupancy vehicles
ISO	International Standards Organization
km	kilometer (1 kilometer ≈ 0.62 miles US)
MOPT	Ministerio de Obras Públicas y Transportes Spanish Ministry of Public Works, Transportation and Environment
mt	metric ton (1 mt ≈ 1.10 US tons)
NAPA	National Asphalt Pavement Association
NHS	National Highway System
NQI	National Quality Initiative
OJT	on-the-job training
Peseta	Spanish currency unit (1 peseta ≈ $0.0074)
P.O.C	point of contact
QC/QA	quality control and quality assurance
R&D	research and development
SAPPR	French concessionaire company
SCETAUROUTE	French common prime construction management and engineering office in charge of preparing project designs and managing the construction work
S	schilling, Austrian currency unit (1 S ≈ $0.086 US)
SEOPANI	Spanish National Association of Construction Companies
SETRA	division of the French Ministry of Transport reponsible for engineering policies

TECH	Tour of European Concrete Highways
TECHNIBERIA	Spanish civil engineering business association
TQM	total quality management
TRB	Transportation Research Board
TTEC	Transportation Technology Evaluation Center
VE	value engineering
VOB	German federal regulations, covering tendering and performance stipulations in contracts for construction works. (These are roughly equivalent to the Title 23, United States Code, Highways, and Title 23, Code of Federal Regulations, Highways.)

APPENDIX 10.3: CONTRACT ADMINISTRATION TECHNIQUES QUESTIONNAIRE

The European hosts were sent the following questions in advance. They used the questions to assemble a group of people who could answer them at meetings with the team.

Contract Administration Techniques for Quality Enhancement Study Tour Questions

1. Please provide a brief summary of your procedures for administering your (construction) program.

2. How are projects typically awarded to contractors? Are projects awarded through a (competitive) bidding process? If so:

   a. How long is the typical advertisement period?
   b. Are public agencies allowed to bid on projects?
   c. Are projects awarded only to the lowest bidder? If not, what other basis is used for making awards?
   d. Have you awarded any projects based on life-cycle cost? (If so, explain your procedure and provide an example.)
   e. What other factors are considered in awarding a contract?

3. Are contractors prequalified prior to bidding? (How is it determined whether or not contractors are qualified?) Is quality considered? How?

4. What information is provided to prospective bidders (i.e., plans, specifications. estimated cost, etc.)?

5. Are alternate bids used (i.e., are bidders ever given more than one design option to bid)?

6. Are bidders allowed to submit a bid for their own design alternative? (If so, how are these bids handled in the award process?)

7. Is the engineer's estimate made public?

8. Are contracts ever negotiated? (If so, under what conditions?)

9. Is force account (i.e., time and materials) used? (If so, under what conditions?)

10. What procedures are used to determine contract time? And what measures are used to encourage contractors to complete projects on time?

    a. Are liquidated damages assessed if the contract time is not met?
    b. Do you use incentive/disincentive clauses for time?

11. Have you used Cost-Plus-Time bidding (e.g., contractor's estimate of contract time used in the low bid determination)? If so:

    a. Briefly describe your procedures.
    b. What factors are used to determine the cost of time?
    c. Is an incentive provision included?

12. Have you used the lane rental concept (i.e., contractor pays a fee for the time that lanes are obstructed)?

13. What is the basis (i.e., engineering/inspection costs, road user costs, etc.) for determining the dollar amount for liquidated damages, incentives/disincentives, and lane rental fees?

14. Is contract work allowed to be subcontracted out? If so:

    a. Is there a limit on the amount of work allowed to be subcontracted?
    b. What is the approval process for subcontractors?

15. Are claims a problem?

    a. How are they handled?
    b. Are alternate dispute resolution methods used? (If so, describe methods used.)

16. How are you assured that the contractor has provided what you have specified? How are you assured that you receive a quality construction product?

17. How is quality defined?

18. Do you typically use "method" or "end result" type specifications? Are they statistically based?

19. Are incentives/disincentives based on product quality (price adjustments) used? If so:

    a. Typically, on what products and on what attributes? How are the attributes measured?
    b. What is the basis for price adjustments (i.e., performance measures)? How is the dollar amount determined?
    c. Are both incentives and disincentives used?
    d. Do contractors reflect anticipated incentives in their bid amounts?
    e. Do you use contractor's test results for payment or acceptance?

20. Do you perform constructability reviews? If so:

    a. Briefly describe your process.
    b. If contractors are used on the review team, how are they selected?
    c. How are the contractors compensated?
    d. Are the review contractors allowed to bid on the projects that they have reviewed?

21. Is the design-build concept being used? If so:

    a. What do you see as the benefits and downfalls to design-build?
    b. Briefly describe your design-build process.

22. To what extent are warranties/guarantees used?

    a. What items are typically warrantied/guaranteed?
    b. How long are the warranty/guarantee periods?
    c. What amount of construction inspection is performed on warrantied/guaranteed projects (or items)?
    d. What are the effects resulting from the use of warranties/guarantees on:
        - Quality?
        - Prices and overall cost?
        - Competition? (Is an advantage created for larger firms?)
    e. How are warranties secured (e.g., performance bonds)? And if bonds are used, for example, how is the bond amount determined (i.e., a percentage of the contract amount)?
    f. How are warranty criteria established? Provide examples.

23. Are contractors required to have a quality control program? If so, how are they certified, or how are the contractor's test results verified?

24. Describe your sampling and testing program.

APPENDIX 10.4: SITES VISITED AND INDIVIDUALS CONSULTED

[Note: Missing events (e.g., GER-1, GER-2) were transportation links or internal team meetings rather than meetings with European hosts.]

A. Event GER-3 (9/20/93)

1. Meeting site:

   BUNDESVERKEHRSMINISTERIUM
   (The Federal Ministry of Transportation)
   Robert Schumann Platz 1
   53175 Bonn, Germany

   P.O.C. Dr. Karl F. Ribbeck
   TEL.: 011-49-228-300-0/-5141
   FAX.: 011-49-228-300-5019

   P.O.C. Ministerialrat Martin Denker
   TEL.: 011-49-228-300-5140

2. Organizations represented:

   The Federal Ministry of Transportation, plus:

   Central Association of the German Construction Trade
   Godesberger Allee 99
   Postfach 20 1455
   P.O.C. Dr. Karl Robl
   TEL.: (0228) 8102-0
   FAX.: 011-49-228-8-10-21-21

   German Building Industry Association
   Am Hofgarten 99
   P.O.C. Mr. Horst Franke
   TEL.: (0228) 267090

   Association of Consulting Engineers
   Am Fronhof 10
   P.O.C. Mr. Klaus Rollenhagen
   TEL.: (0228) 957180

Association of Independent Consulting Engineering Firms
Winston Churchill Strasse 1
P.O.C. Dr. Jurgen Assman
TEL.: (0228) 217063

3. Individuals attending (in alphabetical order):

Dr. Jurgen Assman—Association of Independent Consulting Engineering Firms, Chief Manager
Mr. Hansjurgen Betz—Ministry, Div. StB 10, Road Planning
Mr. Martin Denker—Ministry, Chief of Div. StB 14, Road Construction Research and Development
Mr. Horst Franke—German Building Industry Association, Chief Manager
Mr. Ullrich Habermann—National Association of Roadbuilders
Dr. Holdman—Chief of Central Association of German Construction Trades
Dr. Hans J. Huber—Ministry, Director General of Roads
Mr. Peter Junne—Ministry, Div. StB 12
Mr. Gunter Korting—Ministry, Div. StB 24, Road Construction Budget
Dr. Karl F. Ribbeck—Ministry, Deputy Chief, Div. StB 14
Dr. Karl Robl—Central Association of the German Construction Trade, Chief Manager
Dr. Klaus Rollengarten—Association of Consulting Engineers, Chief Manager
Mr. Waldemar Stern—Ministry, Chief of Div. StB 12, General Conditions of Construction Contracts, Construction Industries
Mr. Edgar Wittman—Ministry, Deputy Chief, Div. StB 26, Road Construction Technology

B. Event GER-5 (9/21/93)

1. Meeting sites:

Southern Autobahn Ring (A10, A115)
Rangsdorf Motorway Maintenance Depot, A10
A13, A15 (Pilot Section 1)
Cottbus-Sud, B97 Cloverleaf

Brandenburg Motorway Office
Stolpe an der Autobahn
16540 Hohen Neuendorf
P.O.C. Dipl.-ing Reuter
TEL.: 804-0 Henningsdorf
P.O.C. Dipl.-ing Szameitat
TEL.: (0332) 804-370
TEL.: (03302) 241 22

2. Organizations represented:

   Various construction sites and Brandenburg Motorway Office, plus:

   Ministry for Urban Development, Lodging, and Transport
   Henning-von Tresckow-Strasse 2-8
   14467 Potsdam
   TEL.: (0331) 332-0 (secretary-5001)
   P.O.C. Minister Vollpracht
   P.O.C. Minister Domhan
   P.O.C. Minister Gwiazdowsky

   Participating Construction Firms
   (e.g. Verkehrsbau-Union)

3. Individuals attending (in alphabetical order):

   Minister Domhan—Ministry, Potsdam
   Dr. Grosshans—Commercial Testing Lab
   Minister Gwiazdowsky—Ministry, Potsdam
   Mr. Heilet—BAU-AG
   Mr. Honer—Contractor
   Dipl.-ing Jahnke—Planning
   Mr. Matuska—private firm
   Dipl.-ing Reuter—Brandenburg Motorway Office
   Dipl.-ing Szameitat—Head of Construction Supervision at Autobahn Stolpe
   Minister Vollpracht—Ministry, Potsdam
   Dipl.-ing Wagner—Manager of Verkehrsbau Union
   Mr. Woerner—BAU-AG

C. Event GER-6 (9/22/93)

1. Meeting site:

   Administration of The Senate for Questions of Construction and Housing
   Wurttembergische Strasse 6
   10707 Berlin, Germany
   P.O.C. Mr. Bernd Misch
   TEL.: (030) 867-4651

2. Organizations represented:

German Building Industry Association
Karl-Liebknecht-Strasse 33
10178 Berlin, Germany
P.O.C. Mr. Klaus Dittner
TEL.: (030) 242-5562
TEL.: (030) 887-6900 or -6985
FAX.: (030) 867-3152
P.O.C. Mrs. Roland
TEL.: (030) 867-3271

Federal Division of Experts for Road Construction
P.O.C. Mr. Ullrich Haberman

3. Individuals attending (in alphabetical order):

Mr. Rudolf Adam—Head of Department Bidding and Awarding
Mr. Frieder Buehring—Director-General for Construction Engineering
Mr. Klaus Dittner—Administration of the Senate
Mr. Ullrich Haberman—(Industry) Manager, Chief Engineer
Mr. Bernd Misch—Director, Construction and Transportation

D. Event FR-2 (9/23/93)

1. Meeting site:

SETRA Headquarters
46 Avenue Aristide Briand
92220 Bagneux (Paris), France
P.O.C. Mr. Eric Boiteux
TEL.: 011-33-1-46-11-31-89
FAX.: 011-33-1-46-11-31-69
P.O.C. Mrs. Genevieve Reymund
TEL.: 011-33-1-46-11-34-25

2. Organizations represented:

SETRA Headquarters, plus:

The Association of French Toll Motorway Companies
Association des Sociétés Françaises d'Autoroutes (A.S.F.A.)
3, rue Edmond Valentine
75007 Paris, France

P.O.C. Mr. Philippe P. Petit
TEL.: 011-33-93-84-61-95
FAX.: 011-33-93-51-42-66

3. Individuals attending (in alphabetical order):

Mr. Eric Boiteux—Office of International Affairs, Department of Public Works, Transport, and Tourism
Mr. Alain Freret—Construction Programs, SETRA
Mr. Philippe P. Petit—A.S.F.A.
Mr. Jean Claude Vautrin—Quality, SETRA Highway Engineering Department
Mr. Gerard Vuillemin—Quality value analysis

E. Event FR-3 (9/23/93)

1. Meeting site:

Working dinner with representatives from 4 of the "top 5" road contractors.
P.O.C. Mr. Sainton—Beugnet Society

2. Organizations represented:

The Beugnet Company, plus:

Cochery-Bourdin-Chausse
COLAS Organization
Jean Lefebvre Company

3. Individuals attending (in alphabetical order):

Mr. Francois Chaignon—Representative, COLAS Organization
Mr. Francois Kasoff—Quality Control
Mr. Albert Marsot—Representative, Jean Lefebvre Company
Mr. Yves Martineau—Representative, Cochery-Bourdin-Chausse
Mr. Yves Meienier—Representative, Beugnet Company
Mr. Sainton—Beugnet Society

F. Event FR-4 (9/24/93)

1. Meeting site:

   Headquarters, Association of the French Toll Highways Corporation
   41 Bis Avenue
   Bosquet, Paris, 7e
   P.O.C. Mr. Philippe P. Petit
   TEL.: 011-33-93-84-61-95
   FAX.: 011-33-93-51-42-66

2. Organizations represented:

   Association of The French Toll Highways Corporation (A.S.F.A.), plus:

   SCETAUROUTE
   SAPRR

3. Individuals attending (in alphabetical order):

   Mr. Claude Bessan—SCETAUROUTE Construction Manager, Troyes Branch
   Mr. Claude Courtier—Quality Assurance, SCETAUROUTE
   Mr. Dominique Gazal—SAPRR Advisor to General Manager, Quality Operations, Maintenance, Service, and EPA
   Mr. Philippe P. Petit—Director of Projects and International Relations
   Mr. Francois Prudhomme—CONFIROUTE Head of Infrastructure

G. Event FR-5 (9/25/93)

1. Meeting site:

   A42 Tollway near Lyon, France
   P.O.C. Mr. Philippe P. Petit
   TEL.: 011-33-93-84-61-95
   FAX.: 011-33-93-51-42-66

2. Organizations represented:

   A42 Tollway, plus:

   SAPRR
   SCETAUROUTE

3. Individuals attending (in alphabetical order):

   Mr. Eric Boiteux—International Affairs, Transport and Tourism
   Mr. Raymond Bourrel—Head of the Dagneux Operations District, SAPRR
   Mr. Pierre Hingart—Managing Construction Engineer, SCETAUROUTE
   Mr. Bernard Leger—Deputy Regional Manager
   Mr. Jacky Martin—Head of the Operations District
   Mr. Jacques Martin—Managing Construction Engineer, SCETAUROUTE
   Mr. Veazey—Control Center

H. Event FR-7 (9/27/93)

1. Meeting site:

   SETRA Headquarters
   46 Avenue Aristide Briand
   92220 Bagneux (Paris), France
   P.O.C. Mr. Eric Boiteux
   TEL.: 011-33-1-46-11-31-89
   FAX.: 011-33-1-46-11-31-69

2. Organizations represented:

   SETRA Headquarters, plus:

   Dumez Company
   Ministry of Finance

3. Individuals attending (in alphabetical order):

   Mr. Eric Boiteux—International Affairs, Department of Public Works, Transport, and Tourism
   Mr. Christian Bouteaux—Dumez Company, Department Manager for Quality
   Mr. Serge Doumain—Ministry of Finance, Central Commission for Contracts
   Mr. Bernard Fabre—SETRA Contract Regulation, Highways and Bridges

I. Event AUS-2 (9/28/93)

1. Meeting site:

Austrian Ministry of Economics
A-1011 Wien Stubenring 1
Vienna, Austria
P.O.C. Dr. Helmut Prager
TEL.: 011-43-1-713-79-95
FAX.: 011-43-1-711-00

2. Organizations represented:

Austrian Ministry of Economics, plus:

Fachverband der Bauindustrie Osterreichs
A-1040 Wien Karlgasse 5
Vienna, Austria
P.O.C. Dipl.-ing Martin Car
FAX.: 011-43-1-504-15-55

3. Individuals attending (in alphabetical order):

Dipl.-ing Martin Car—Fachverband der Baudindustrie Österreichs
Mr. Hofstater—Federal Ministry of Finance
Dr. Helmut Prager—Director, Construction, Operations, and Maintenance for Federal Highways

J. Event AUS-3 (9/29/93)

1. Meeting site:

Tour of A-4 Highway Construction Site, near Vienna City

2. Organizations represented:

A-4 Highway Construction Site
ASAG Company
Habau Hoch Company

3. Individuals attending (in alphabetical order):

Mr. Karl Tunar—Design Engineer, Habau Hoch Company
Mr. Wilman—Technical Vice-President, ASAG Company

K. Event SP-2 (9/30/93)

1. Meeting site:

Ministry of Public Works, Transportation, and Environment (MOPT)
P. de La Castellana, 67
28701 Madrid, Spain
P.O.C. Dr. Angel Lacleta-Muñoz
TEL.: 011-34-1-308-23-18
TEL.: 011-34-1-553-10-30
FAX.: 011-34-1-308-23-19
FAX.: 011-34-1-556-49-28
P.O.C. Mr. Liberto Serret Izquierdo
TEL.: 011-34-1-597-8326
FAX.: 011-34-1-553-79-30

2. Organizations represented:

Ministry of Public Works, Transportation, and Environment (MOPT)
Civil Engineering Business Association (TECHNIBERIA)
National Association of Construction Companies (SEOPANI)

3. Individuals attending (in alphabetical order):

Mr. Justo Borrajo—Ministry, Investment Levels
Mr. Pablo Bueno—Central Administration and Regions, TYPSA
Mr. Francisco Catina—Contracts Procedure
Dr. J. J. Dombriz—General Director of National Highways
Mr. Pedro Esquerdo—Assistant General Director for Planning
Mr. Fernandez—National Highways, Madrid Jurisdiction, General Highway Administration
Mr. Pedro Galan—Highway Safety
Mr. P. Gonzales-Haba—National Association of Construction Companies (SEOPANI), Director of External Management
Mr. Juan Herrera—Consultant Engineer, Quality Control, Civil Engineering Business Association (TECNIBERIA)
Mr. Pedro Isquederos—Director of Planning for Highways
Mr. Liberto Serret Izquierdo—Director General of Highways, International Relations Division
Mr. Juan Lazcano—Assistant Director General of Construction for General Highway Administration
Dr. Angel Lacleta-Muñoz—President, Technical Association of Highways
Mr. Puertas—Engineer, Quality Assessment and Performance Evaluation
Mr. Purani—SEOPANI representative
Mr. Pablo Buena Sainz—President of Consulting Engineers of Spain

L. Event SP-3 (10/1/93)

1. Meeting sites:

Ministry of Public Works, Transportation, and Environment (MOPT)
P. de La Castellana, 67
28701 Madrid, Spain
P.O.C. Dr. Angel Lacleta-Muñoz
TEL.: 011-34-1-308-23-18
TEL.: 011-34-1-553-10-30
FAX.: 011-34-1-308-23-19
FAX.: 011-34-1-556-49-28
P.O.C. Mr. Liberto Serret Izquierdo
TEL.: 011-34-1-597-8326
FAX.: 011-34-1-553-79-30

The Fourth Belt of Madrid (Highway)
P.O.C. Mr. R. Alberola
P.O.C. Mr. J. R. Paramio

2. Organizations represented:

Ministry of Public Works, Transportation, and Environment (MOPT), plus:

The Fourth Belt of Madrid (Highway)

3. Individuals attending (in alphabetical order):

Ms. M. J. Fraile—Community of Madrid
Mr. A. Herrero—General Director of Roads
Mr. Liberto Serret Izquierdo—Director General of Highways, International Relations Division
Mr. Juan Jose Jarillo—Construction Quality Control
Mr. E. Maralles—Vice Council of Transportation, Madrid
Dr. Angel Lacleta-Muñoz—President, Technical Association of Highways
Mr. Puertas—Consulting Engineer
Mr. Juan Antonio de la Riva—Quality Assessment and Performance Evaluation

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